Lunar Samples

Macro Photography/Polarized Light Microscopy

Tom R. Chambers, former research analyst at the Lunar Receiving Laboratory (Biological Sciences Section) during Project Apollo (1969-1972) showcases a sampling of lunar rocks in the form of posters revealing their macro and micro characteristics. He edited and enhanced the "raw" Images. These images and information are courtesy of NASA.

Macro Photography: an image whose subject/object is reproduced to at least 1:1. The image on the camera sensor or film plate is the same size, or even bigger, than the real-life subject.

Polarized Light Microscopy: a technique including illumination of the sample with polarized light. This technique is used on samples where the polarized light interacts strongly with the sample and so generating contrast with the background. Polarized light microscopy is used extensively in optical mineralogy.

Apollo 11

Macro Photography

Lunar Sample 10021

Contingency

NASA

Apollo 11
Sample Type: rock.
Lithology: breccia.
Description: a friable soil breccia. It breaks into rounded pieces. It was collected as part of the contingency sample from the area immediately in front of the Lunar Module (LM). It is a very mature regolith and was found to have more He than any other Lunar breccia. The matrix is made up of brown-black glass and does not appear to be very porous. Glass spheres and fragments are common, with a wide range of color and composition.
Dimensions/Weight: 7.5x6x3.5cm/250gm.

Lunar Sample 10003

NASA

Apollo 11
Sample Type: rock.
Lithology: basalt.
Description: medium-grained subophitic basalt composed of clinopyroxene, two generations of plagioclase, ilmenite with subordinate cristobalite and mesostasis.
Dimensions/Weight: 7x4.5x3.5cm/213gm.

Lunar Sample 10017

NASA

Apollo 11
Sample Type: rock.
Lithology: basalt.
Description: fine-grained, poikilitic, vesicular basalt composed of clinopyroxene, plagioclase, two generations of ilmenite and subordinate opaques and mesostasis.
Dimensions/Weight: 16x11x6cm/973gm.

Lunar Sample 10019

NASA

Apollo 11
Sample Type: rock.
Lithology: breccia.
Description: surface is sparsely covered with glassy spatter. Some glass on the surface is honey brown in color, with some small brown clasts (1mm) which have a crushed glass appearance.
Dimensions/Weight: 7x4x4cm/297gm.

Lunar Sample 10009

NASA

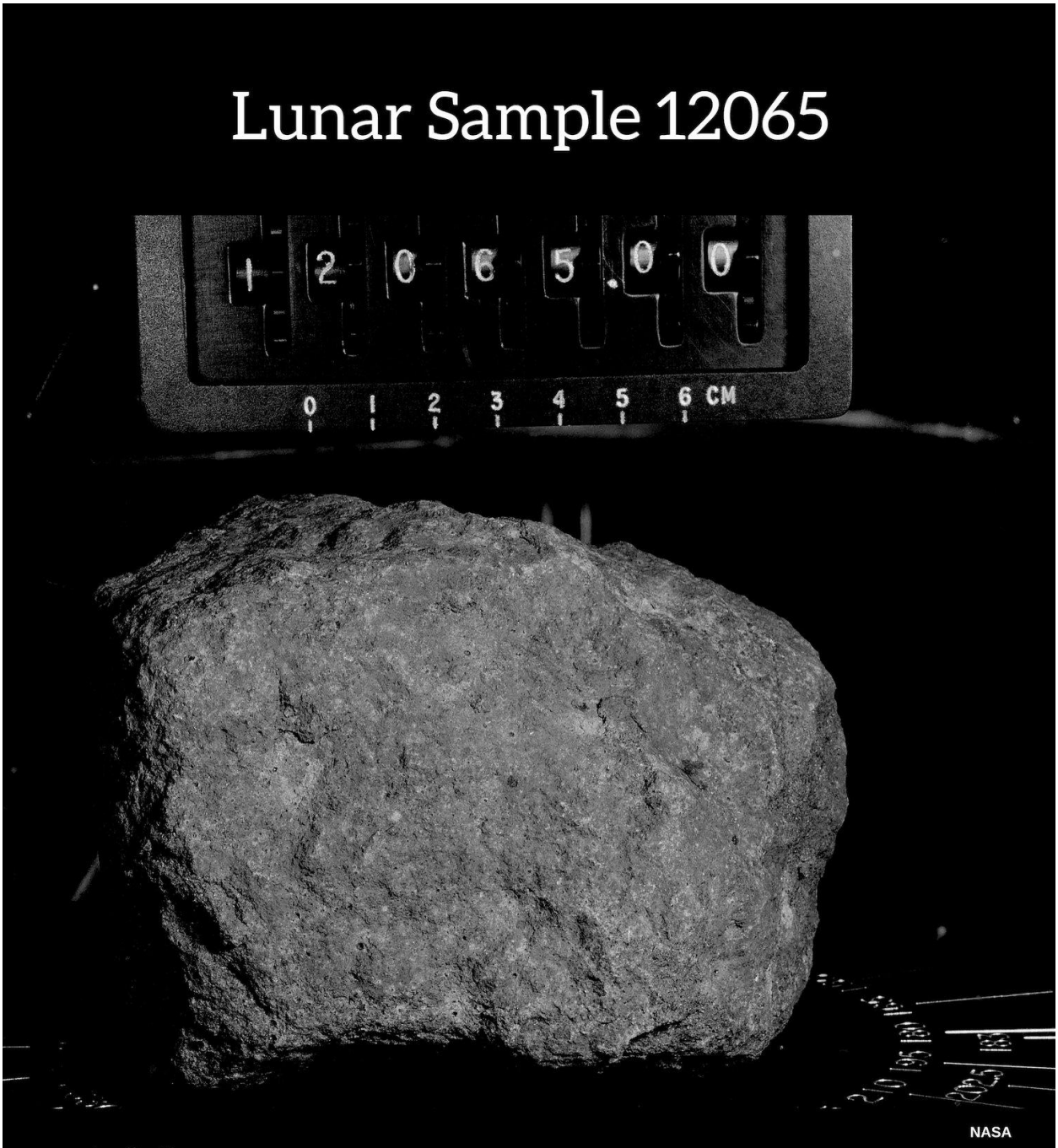
Apollo 11
Sample Type: rock.
Lithology: breccia.
Description: highly devitrified breccia with high glass clast content.
Dimensions/Weight: 5x5x4cm/112gm.

Lunar Sample 12038

NASA

Apollo 12
Sample Type: rock.
Lithology: basalt.
Description: it is distinctly different from the otherApollo 12 basalts. It has more feldspar. The texture is hypidiomorphic and dominantly equigranular. Plagioclase laths form a loose, randomly oriented network in which pyroxene is either interstitial or partially enclosed. Also present is acicular ilmenite, interstitial cristobalite, trace Ca-phosphate, fayalite, ulvöspinel, K-feldspar, troilite, K-glass and Fe-metal.
Dimensions/Weight: 12.5x7.5x5.5cm/746gm.

Lunar Sample 12065



Apollo 12
Sample Type: rock.
Lithology: basalt.
Description: it is a large rounded pigeonite basalt. The outer surface is covered with micrometeorite pits on all sides. It is variolitic, composed of pyroxene and olivine phenocrysts imbedded in a very fine matrix of feathery ilmenite, plagioclase and clinopyroxene.
Dimensions/Weight: 11.8x12x9cm/2109gm.

Lunar Sample 12062

NASA

Apollo 12
Sample Type: rock.
Lithology: basalt.
Description: it is a subophitic ilmenite basalt with a high percentage of pyroxene and medium grain size.
Dimensions/Weight: 12x8x4cm/788gm.

Lunar Sample 14006

Contingency

NASA

Apollo 14
Sample Type: rock.
Lithology: breccia.
Description: it was collected as part of the contingency sample during the first EVA in the vicinity of the Lunar Module (LM). It is a greater than 1 cm rock chip of the Fra Mauro type sieved from the contingency sample. The matrix is fine-grained with inter-grown plagioclase, cliopyroxene and ilmenite. It is pitted with one fresh surface. The pits are glass-lined and vary in size from 0.3 to 0.7 mm. Pit density is very low.
Dimensions/Weight: 3x2x1.3cm/12gm.

Lunar Sample 14049

NASA

Apollo 14
Sample Type: rock.
Lithology: breccia.
Description: it was collected during the second EVA from Station Bg (crater rim). It is a very fine-grained clastic rock having less than 1% of subrounded light-colored clasts in a medium-gray matrix. It has a high carbon content, and it is lacking in zap pits and has no cavities or fractures visible on the surface. Mineral grains that were identified include transparent feldspar, greenish and brownish glass, and one dark brown spherule.
Dimensions/Weight: 8x5x4cm/200gm.

Lunar Sample 14072

NASA

Apollo 14
Sample Type: rock.
Lithology: basalt.
Description: it was picked up on the rim of Cone Crater. It is highly reduced with unique masses of spongy metallic iron in the mesostasis. It is a porphyritic basalt with medium-sized olivine phenocrysts, subophitc to ophitic texture and little glass in its residium. Olivine appears as large, sub-rounded pheopcrysts as inclusions in large pyroxenes and as part of the late-stage assemblage with cristobalite and spongy network of native iron.
Dimensions/Weight: 4.1x3.4x2.1cm/45gm.

Lunar Sample 15415

NASA

Apollo 15
Sample Type: rock.
Lithology: anorthosite.
Description: It was found perched on a clod of soil breccia on the rim of Spur Crater. During the trans-Earth coast press conference, it was called the "Genesis Rock". It is coarse-grained, made almost entirely of calcic plagioclase and probably from the Lunar highlands. An age of about 4 billion years was determined by the Ar plateau method. The lack of meteoritical siderophiles proves its pristineness (lack of contamination by impacts).
Dimensions/Weight: -/269gm.

Lunar Sample 15015

NASA

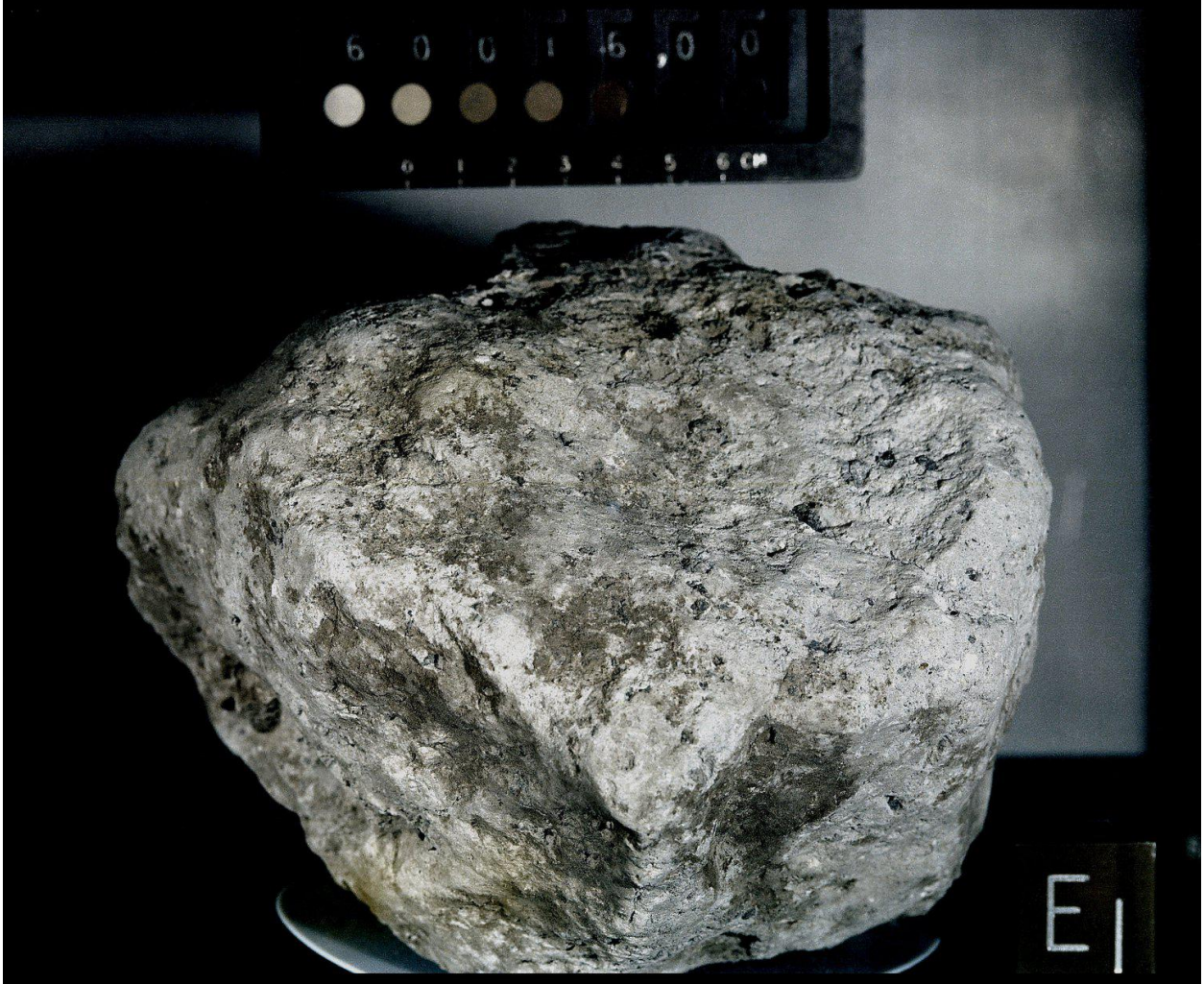
Apollo 15
Sample Type: rock.
Lithology: breccia.
Description: it is collected from the mare surface in front of the Lunar Module. It is a glass covered soil breccia with a rind of glass on all sides. It contains a high percentage of glass fragments including plastic forms, twisted and ropy forms, spheres and broken fragments. Lithic clasts make up about 10% of the volume. They are about 30% mare basalts, 33% Fra Mauro basalts, 22% feldspathic basalts and 15% impact melt rock.
Dimensions/Weight: -/4770gm.

Lunar Sample 15016

NASA

Apollo 15
Sample Type: rock.
Lithology: basalt.
Description: it is the only sample collected at Station 3. It is a highly-vesicular, olivine-normative, basalt with a major element composition. It has subhedral phenocrysts of zoned pyroxene (1-2 mm) and olivine (~1 mm) set in a matrix of subophitic intergrowths of pyroxene and plagioclase. Vesicles (1 to 5 mm) make up about 50% of the volume. Opaque minerals (ilmenite and ulvöspinel) frequently border the vesicles.
Dimensions/Weight: -/923gm.

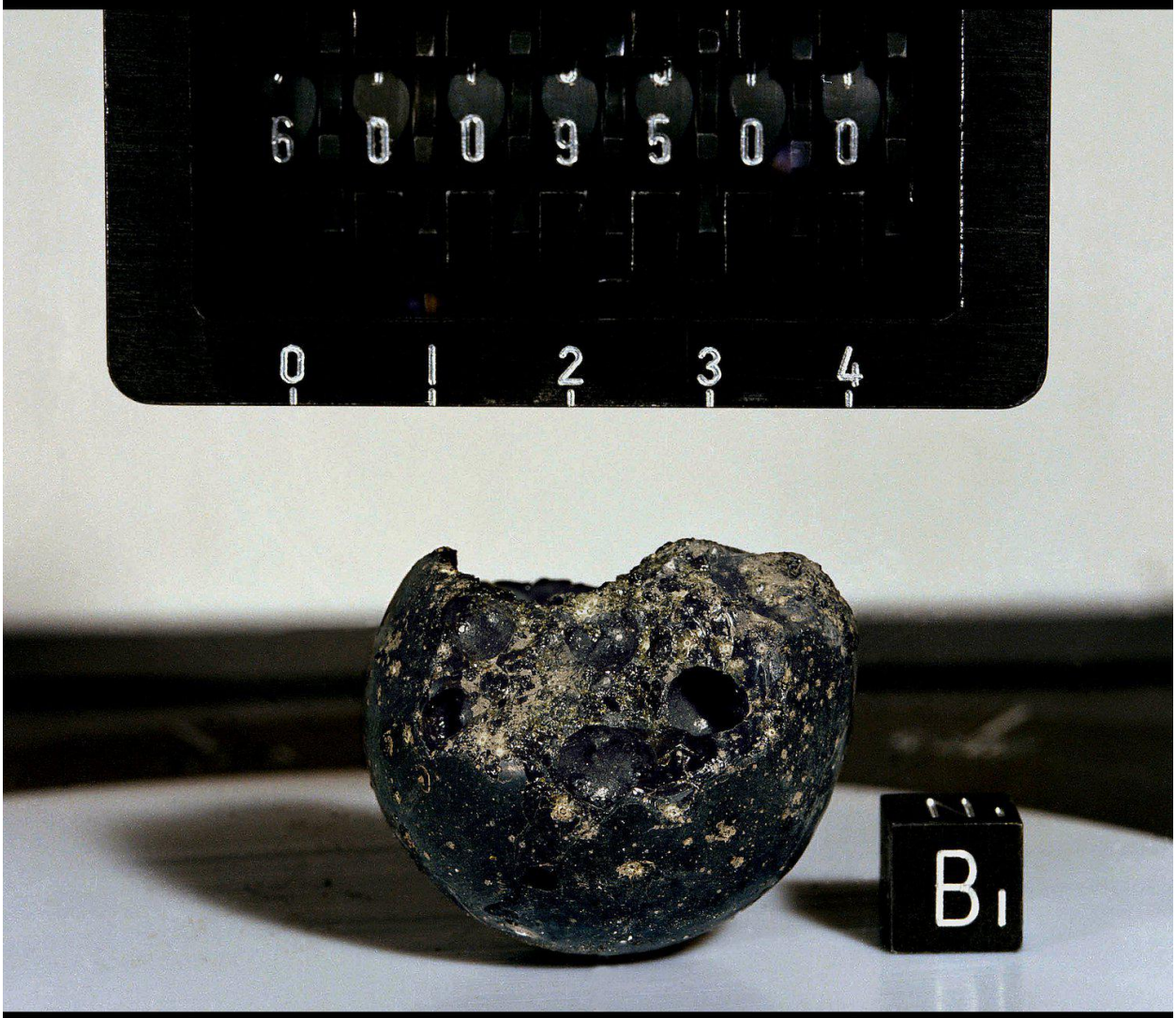
Lunar Sample 60016



NASA

Apollo 16
Sample Type: rock.
Lithology: breccia.
Description: it was found near the Lunar Module and collected at the end of the third EVA. It is regarded as an "ancient" regolith breccia. Micrometeorite craters are found on all surfaces. It is polymict with lithic clasts including cataclastic and recrystallized anorthosite, coarse-and fine-grained poikilitic impact melt, granoblastic material, noritic anorthosite, dark matrix breccias, and several types of glass fragments in various stages of devitrification.
Dimensions/Weight: -/4307gm.

Lunar Sample 60095



NASA

Apollo 16
Sample Type: rock.
Lithology: green glass vitrophyres.
Description: it was observed sitting on the Lunar surface while placing the heat flow probe in the deep drill hole. It is a glass sphere, and it is partly broken showing large vesicles inside. The outer surface is smooth, having formed by cooling in a vacuum, but with some cooling cracks and micrometeorite pits. Small rounded bleb of metal with associated troilite and schreibersite are abundant.
Dimensions/Weight: 2.6cm in diameter/46gm.

Lunar Sample 60625

NASA

Apollo 16
Sample Type: rock.
Lithology: breccia.
Description: it is a white rock, peppered with micrometeorite pits on all sides. It was collected as a rake sample from the area near the Lunar Module. The composition shows it is plagioclase-rich. Its texture has irregular oikocrysts (pyroxene) up to 1mm, enclosing euhedral plagioclase chadocrysts.
Dimensions/Weight: -/117gm.

Lunar Sample 72395

NASA

Apollo 17
Sample Type: rock.
Lithology: breccia.
Description: it was chipped from the #2 boulder at Station 2 on the landslide off of the South Massif. Its ground-mass consists of an interlocking network of small pyroxene oikocrysts that enclose abundant chaodcrysts of plagioclase. Plagioclase-rich clasts are the dominant lithic fragment. It has high meteoritic siderophiles. Metallic iron is meteoritic in origin.
Dimensions/Weight: 12x9x5.5cm/536gm.

Lunar Sample 72215

NASA

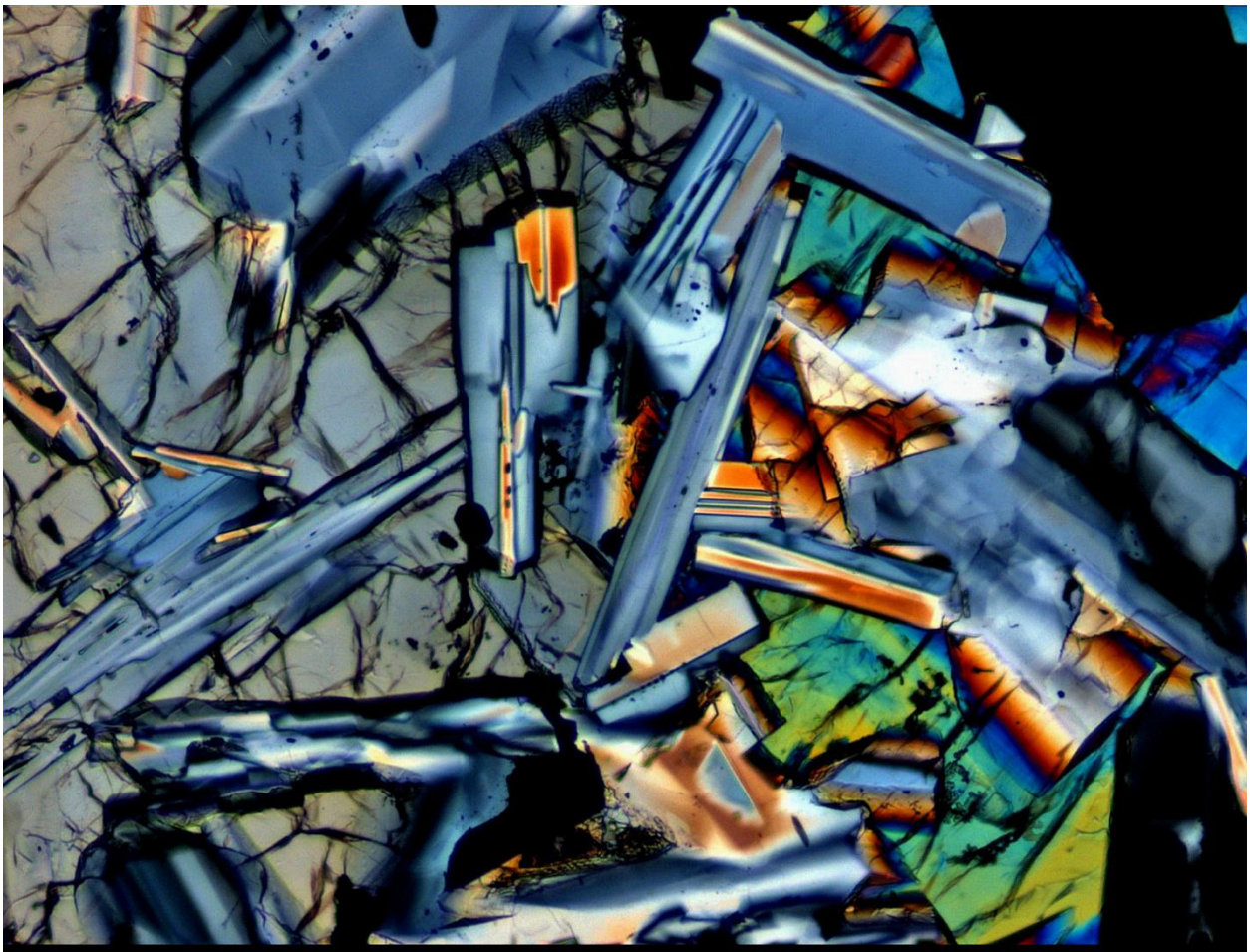
Apollo 17
Sample Type: rock.
Lithology: breccia.
Description: it was collected from the side of a layered boulder #1 at Station 2 located on the bottom slope of the South Massif. It is a coherent, clast-rich, impact-melt breccia. It is aluminous and feldspathic and contains numerous small patches of "granitic" material. Equidimentional chadocrysts of plagioclase are embedded in large pyroxene oikocrysts.
Dimensions/Weight: -/379gm.

Lunar Sample 70175

NASA

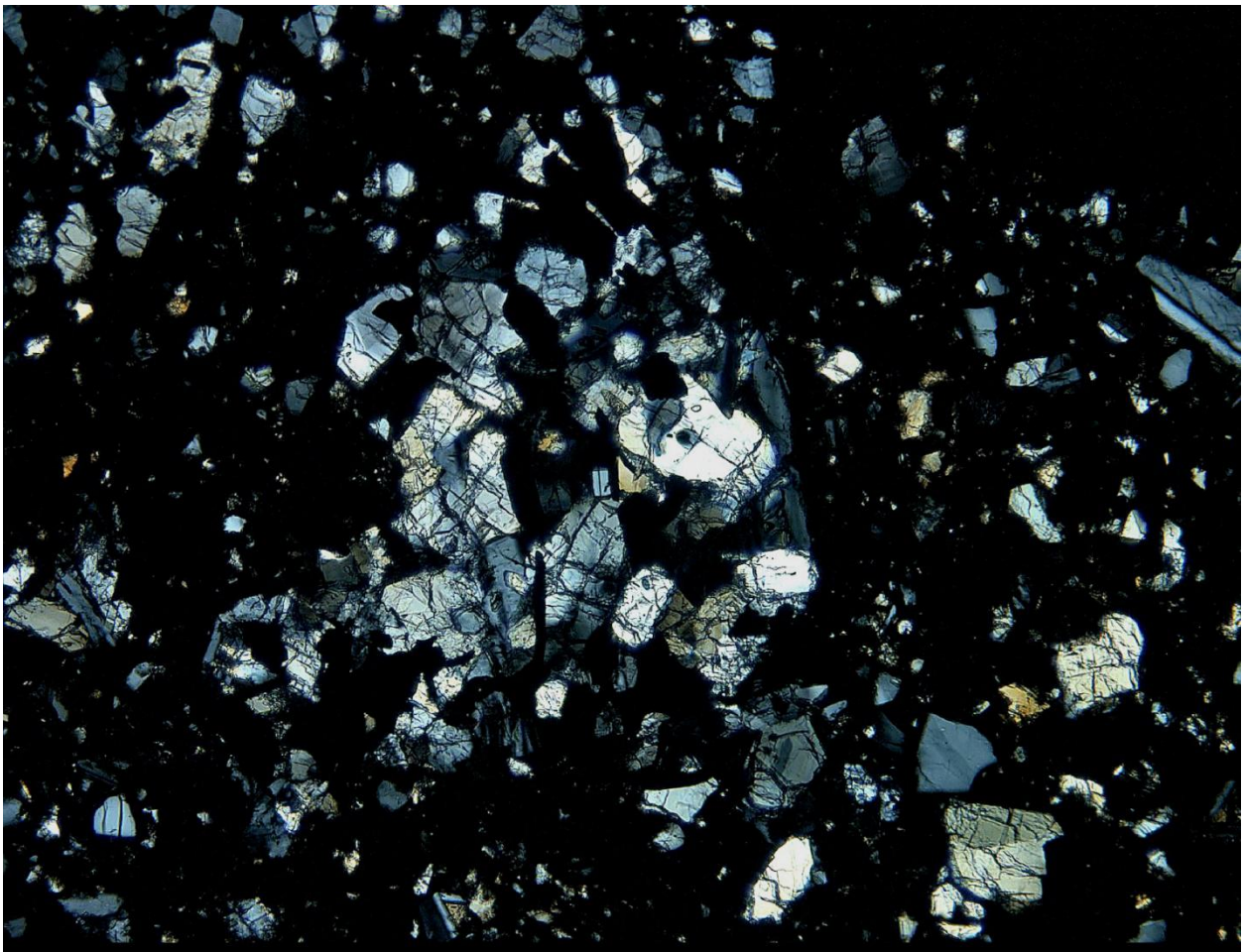
Apollo 17
Sample Type: rock.
Lithology: breccia.
Description: it was collected near the deep drill at the ALSEP site, and it has a high proportion of "orange glass". It was found to have high cosmic-ray-induced activity. There is one large zap pit. The glass includes spheres, shards, veins and matrix. Much of the glass is devitrified, making it appear black. There are veins and clasts of clast-rich, yellow-orange glass. Ilmenite is present, but is very fine-grained and "skeletal".
Dimensions/Weight: -/339gm.

Polarized Light Microscopy



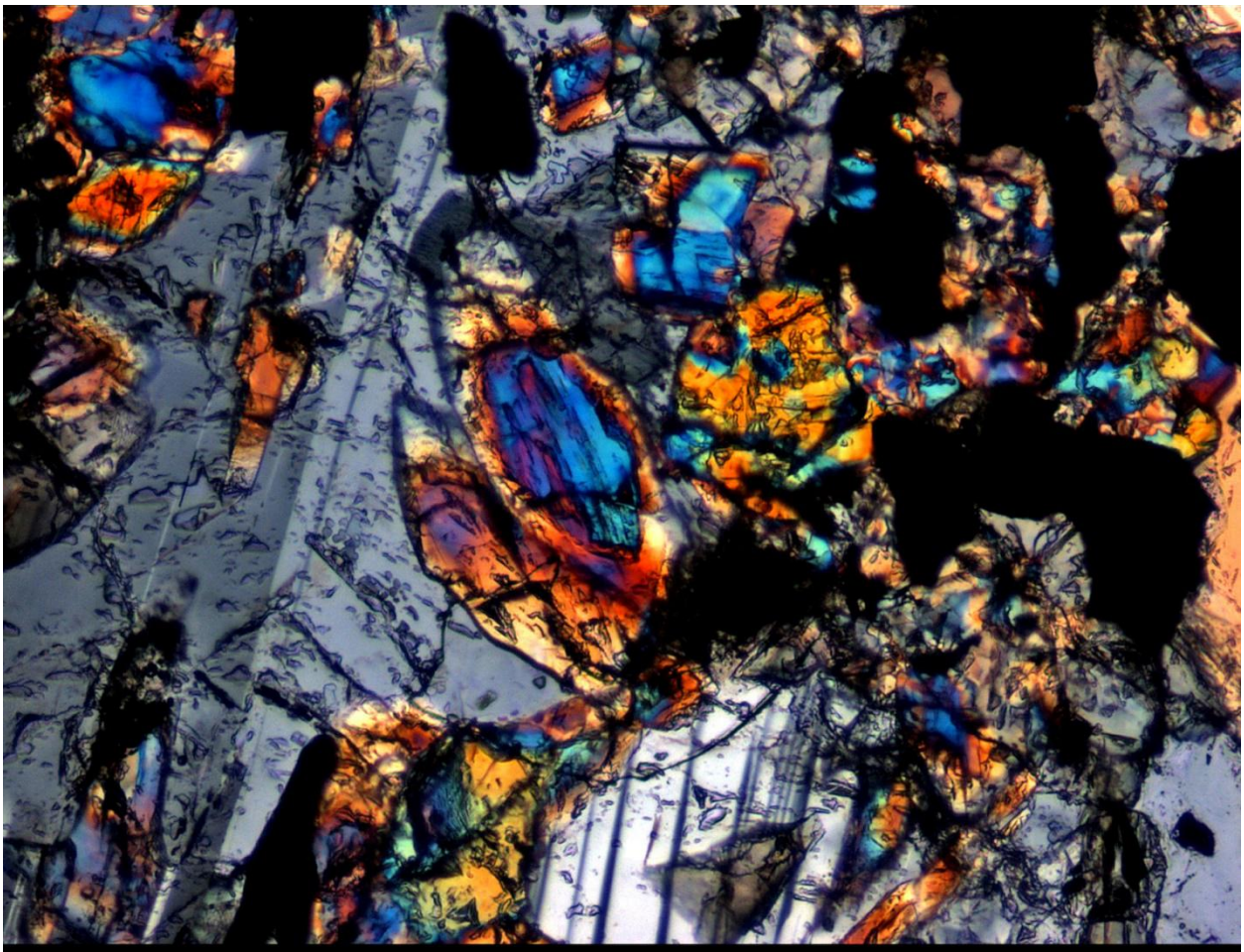
NASA

Mission Apollo 11
Sample 10003
Split 153
Photo Number JSC04095
Lithology basalt
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 0.70 mm
Magnification 10x
Source JSC



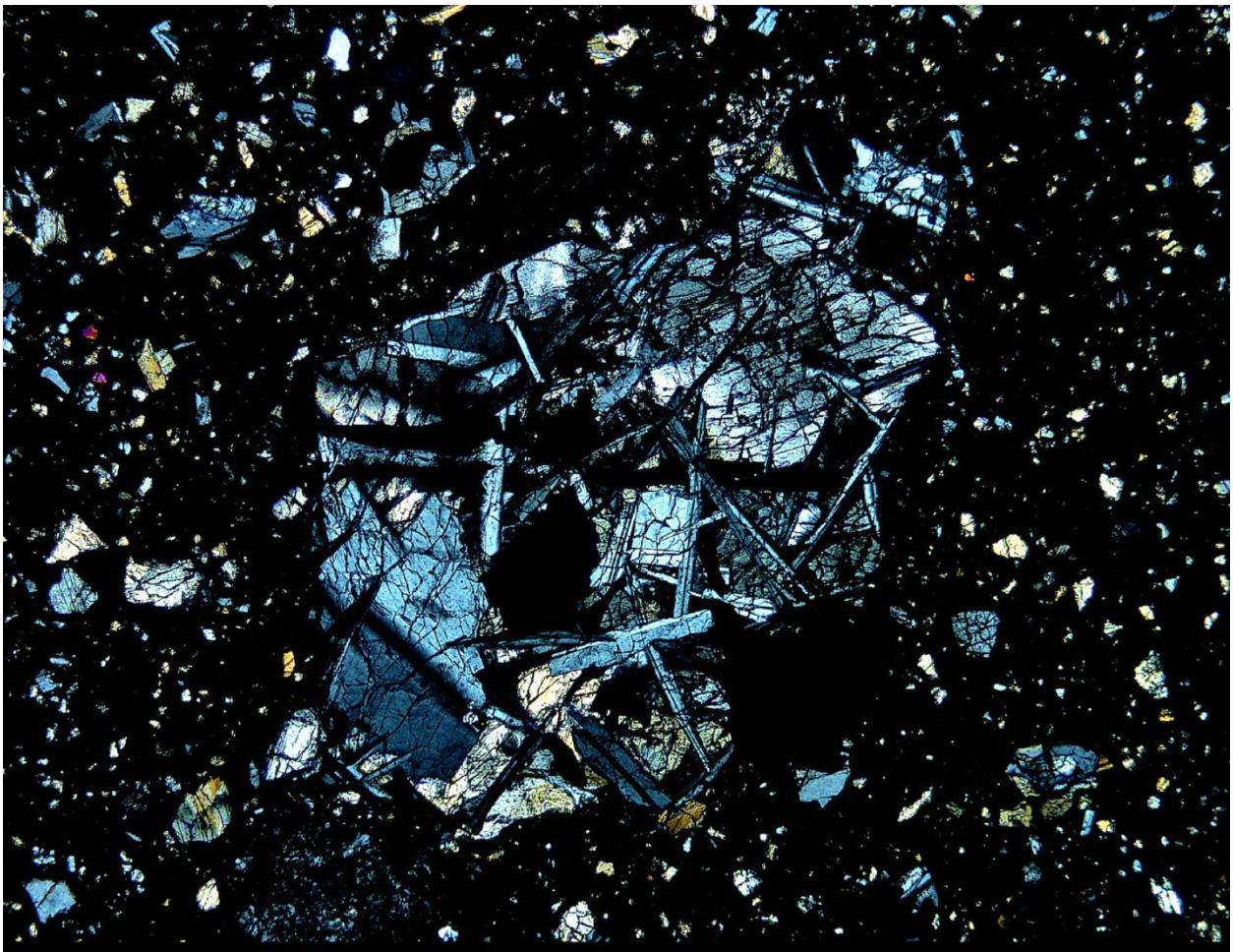
NASA

Mission Apollo 11
Sample 10009
Split 19
Photo Number JSC03489
Lithology breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 1.15 mm
Magnification 10x
Source JSC

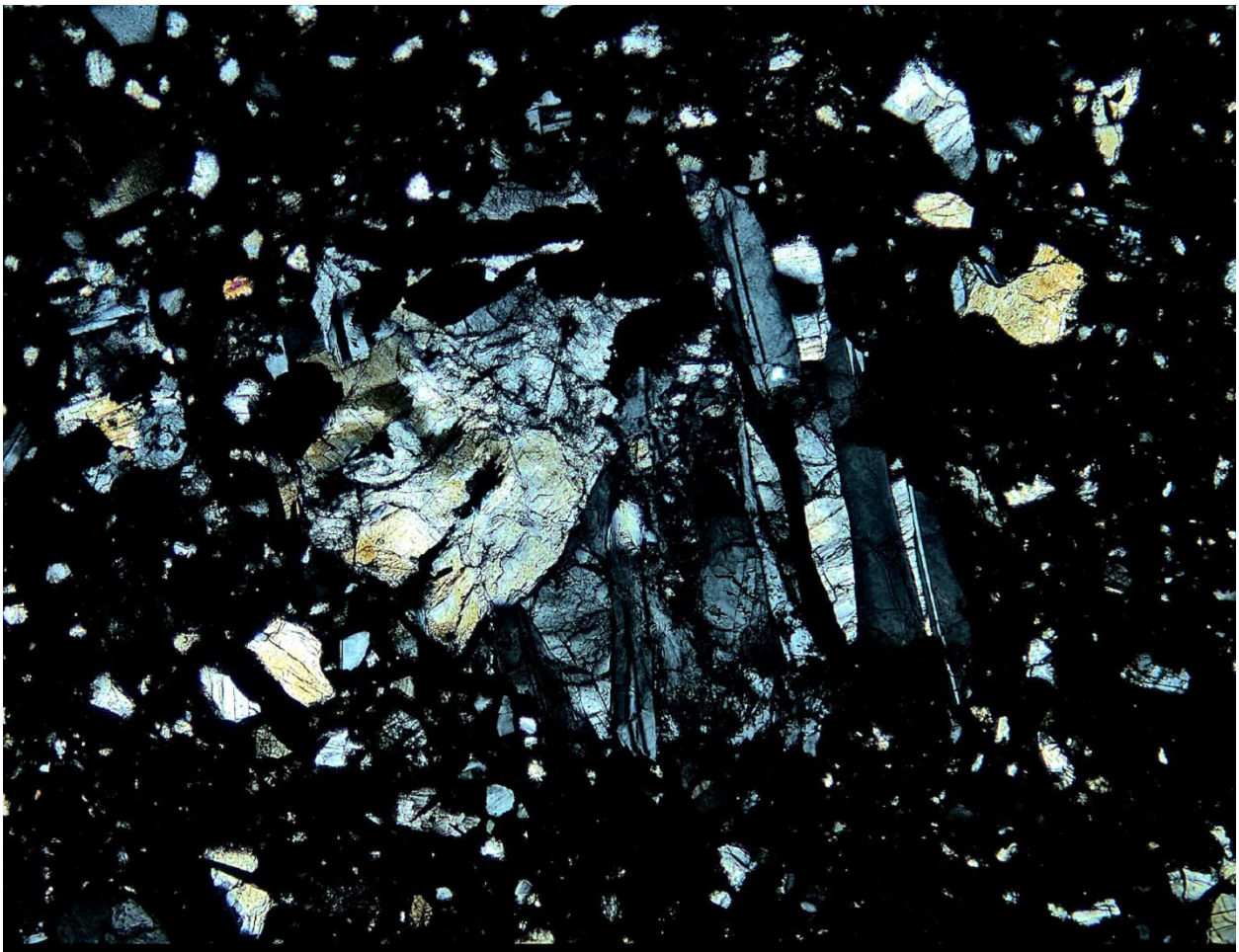


NASA

Mission Apollo 11
Sample 10017
Split 336
Photo Number JSC04116
Lithology basalt
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 0.70 mm
Magnification 10x
Source JSC

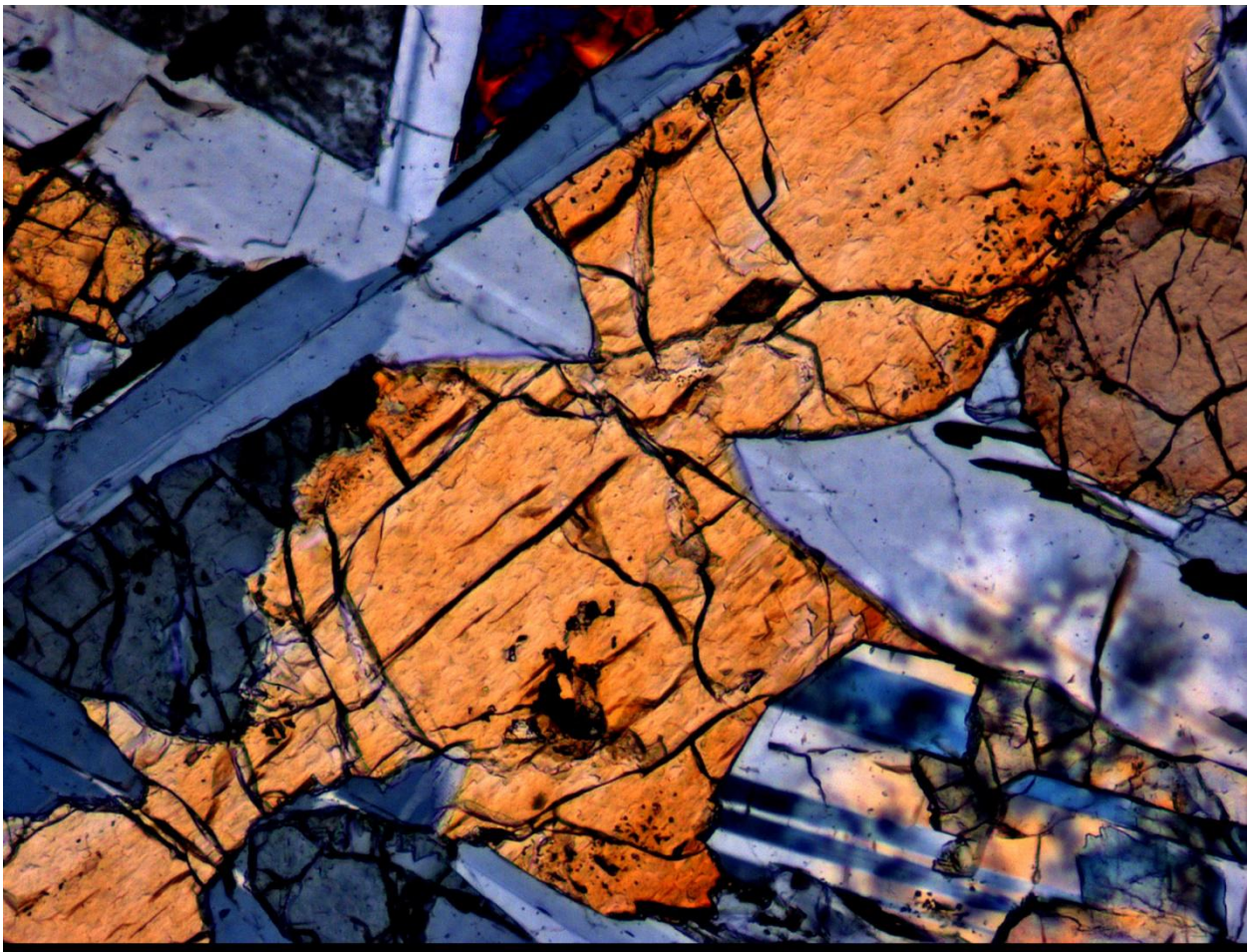


Mission Apollo 11
Sample 10019
Split 14
Photo Number JSC03507
Lithology breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 2.30 mm
Magnification 5x
Source JSC



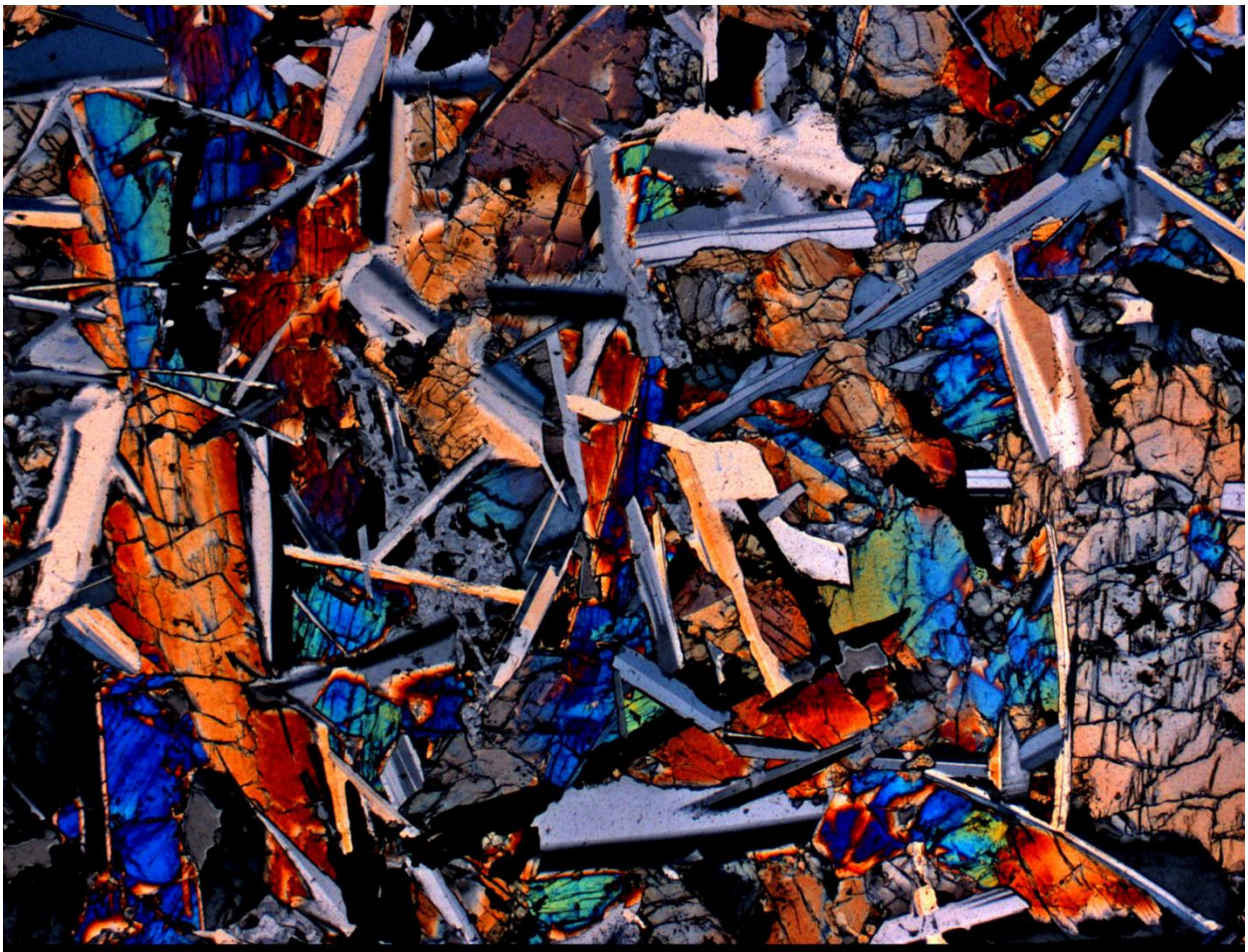
NASA

Mission Apollo 11
Sample 10021
Split 29
Photo Number JSC03543
Lithology breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 1.15 mm
Magnification 10x
Source JSC



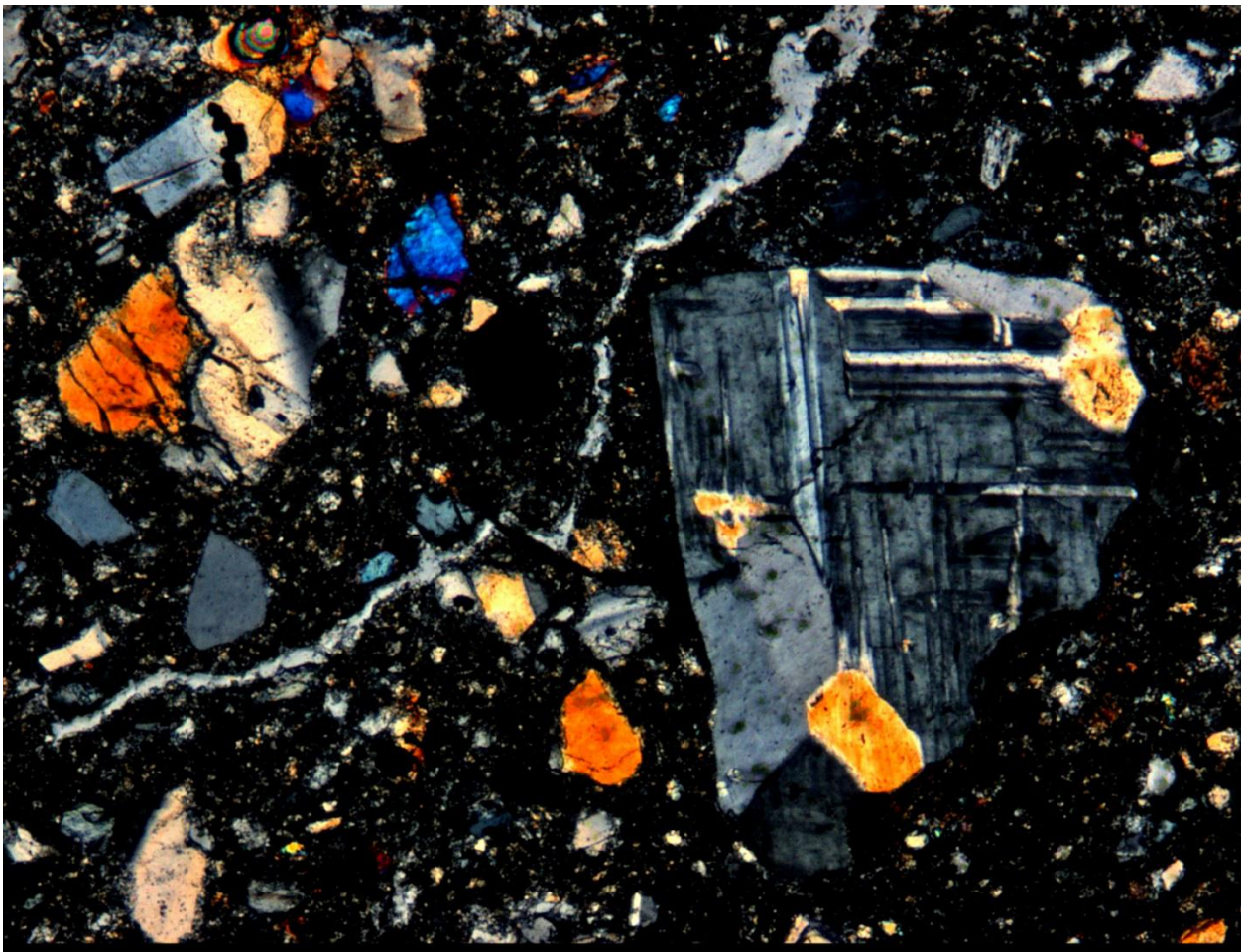
NASA

Mission Apollo 12
Sample 12038
Split 64
Photo Number JSC00942
Lithology basalt
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 0.70 mm
Magnification 10x
Source JSC



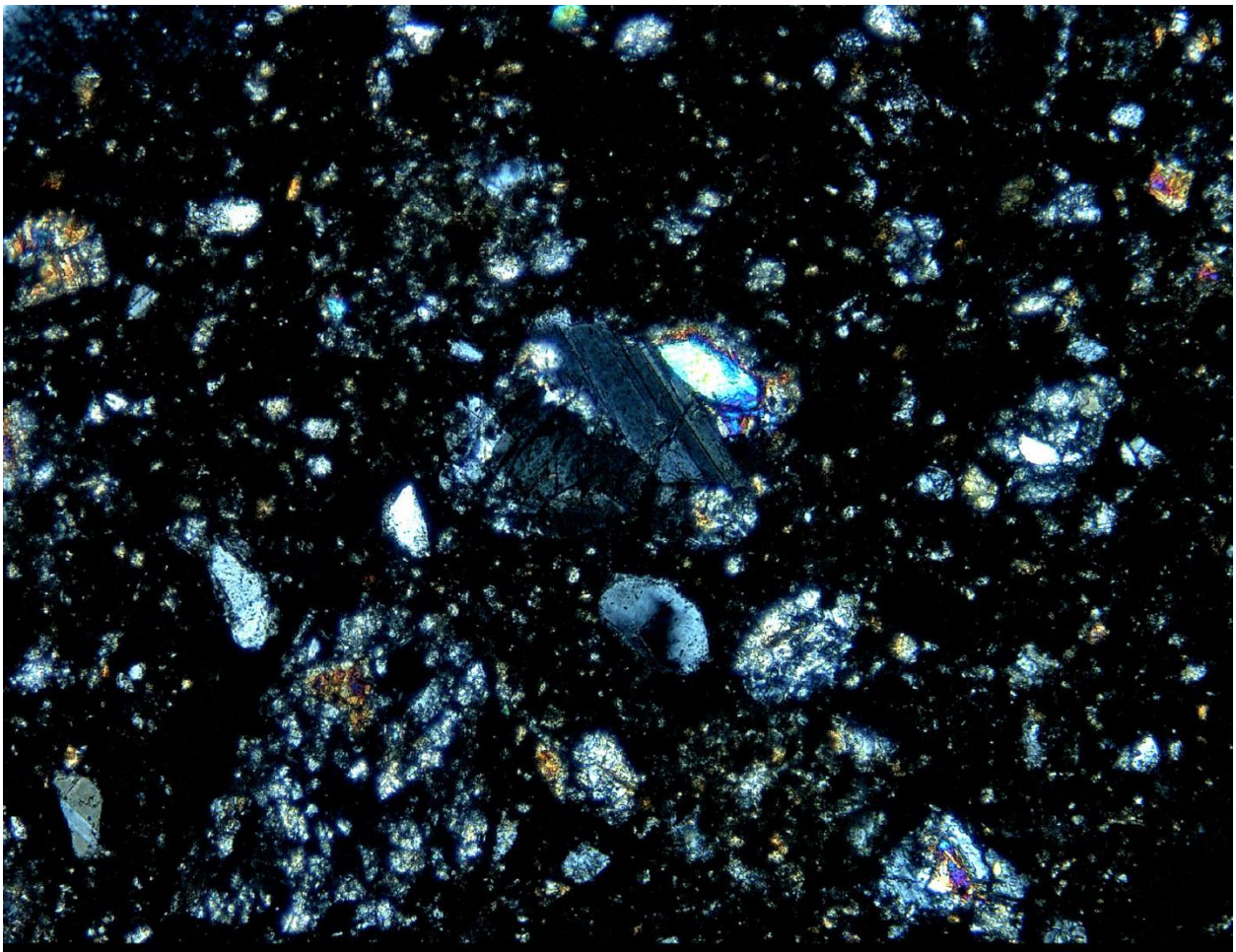
NASA

Mission Apollo 12
Sample 12062
Split 9
Photo Number JSC01029
Lithology basalt
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 2.85 mm
Magnification 2.5x
Source JSC



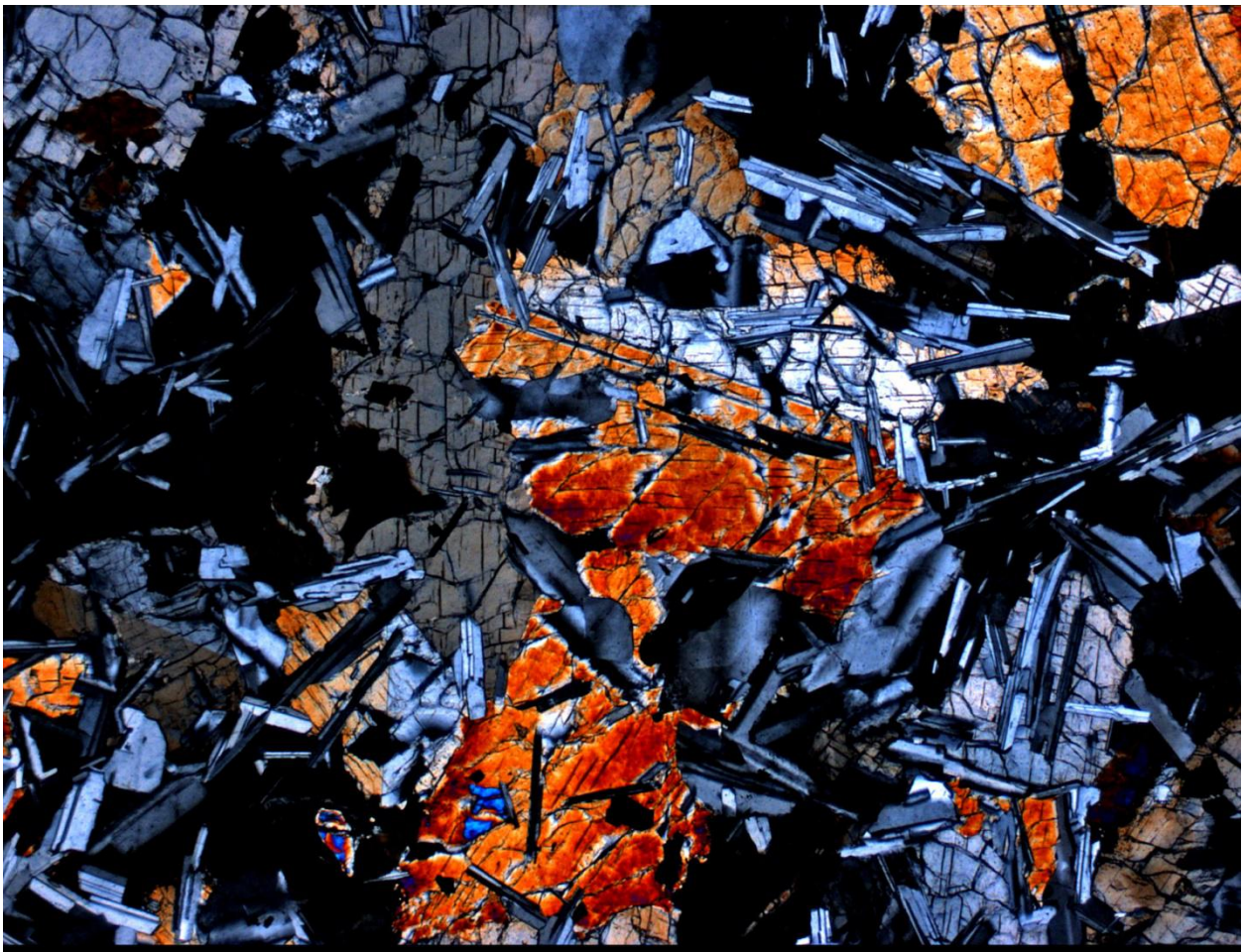
NASA

Mission Apollo 14
Sample 14006
Split 6
Photo Number JSC07182
Lithology breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 1.40 mm
Magnification 5x
Source JSC



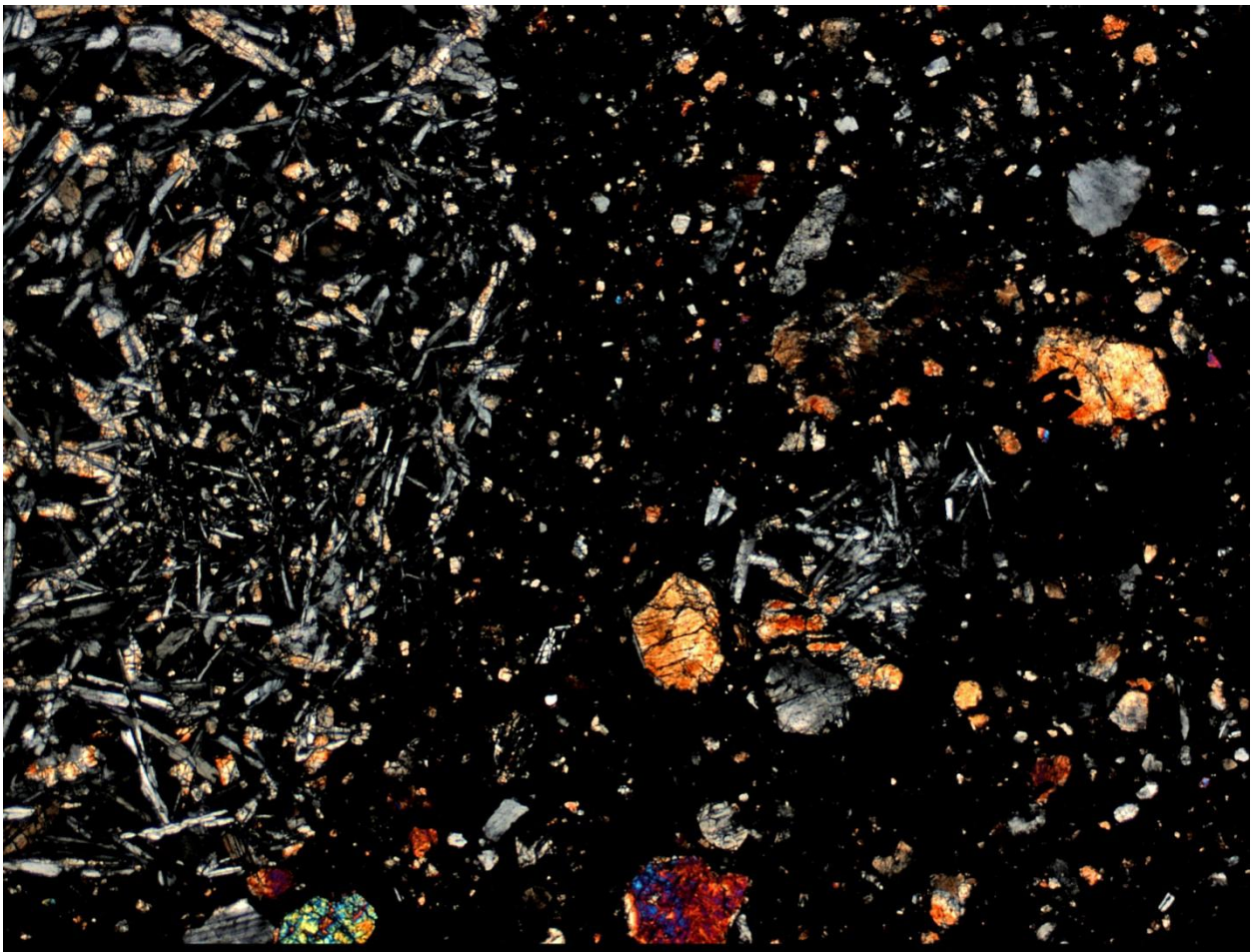
NASA

Mission Apollo 14
Sample 14049
Split 6
Photo Number JSC03057
Lithology fragmental breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 1.15 mm
Magnification 10x
Source JSC



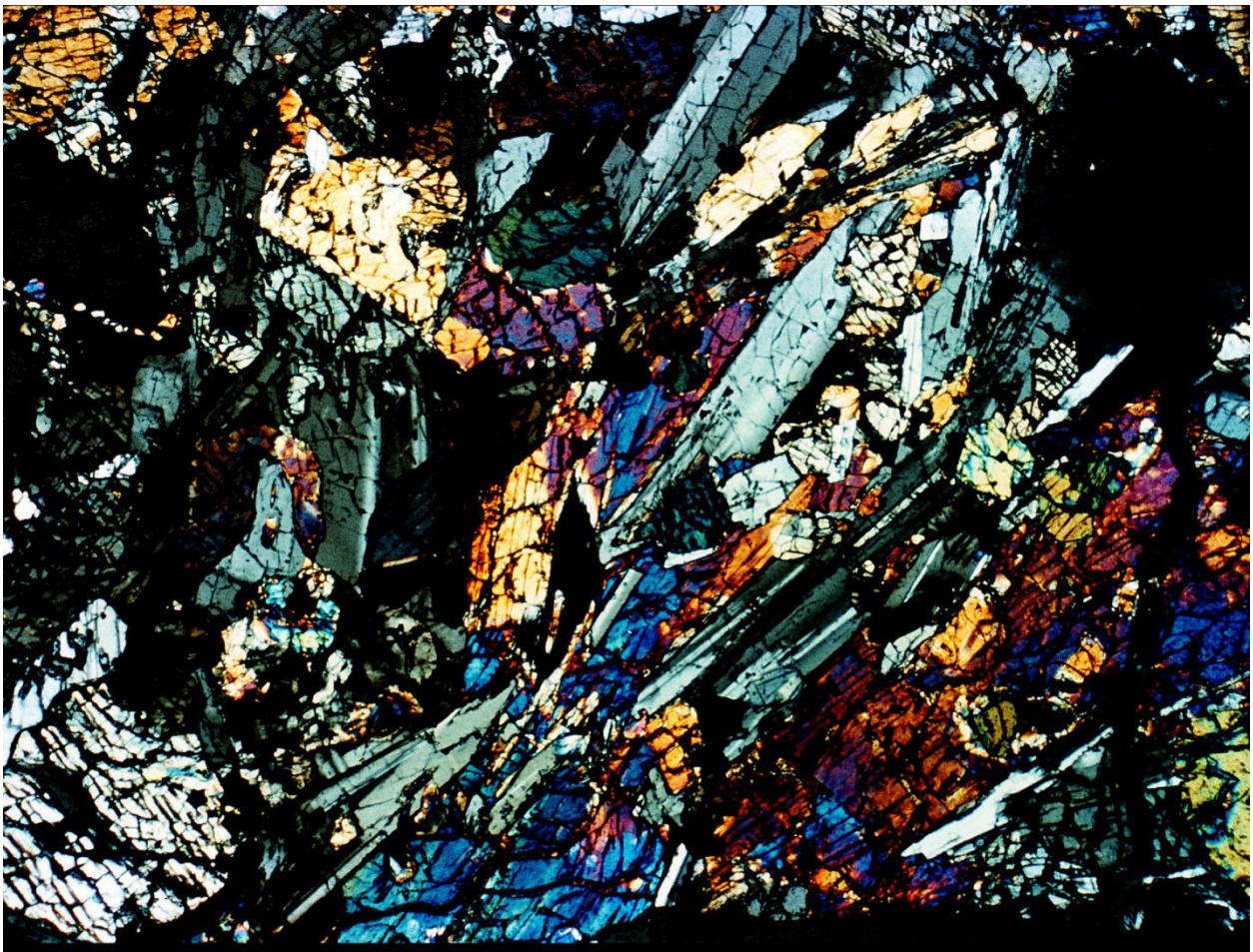
NASA

Mission Apollo 14
Sample 14072
Split 11
Photo Number JSC01238
Lithology basalt
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 2.85 mm
Magnification 2.5x
Source JSC

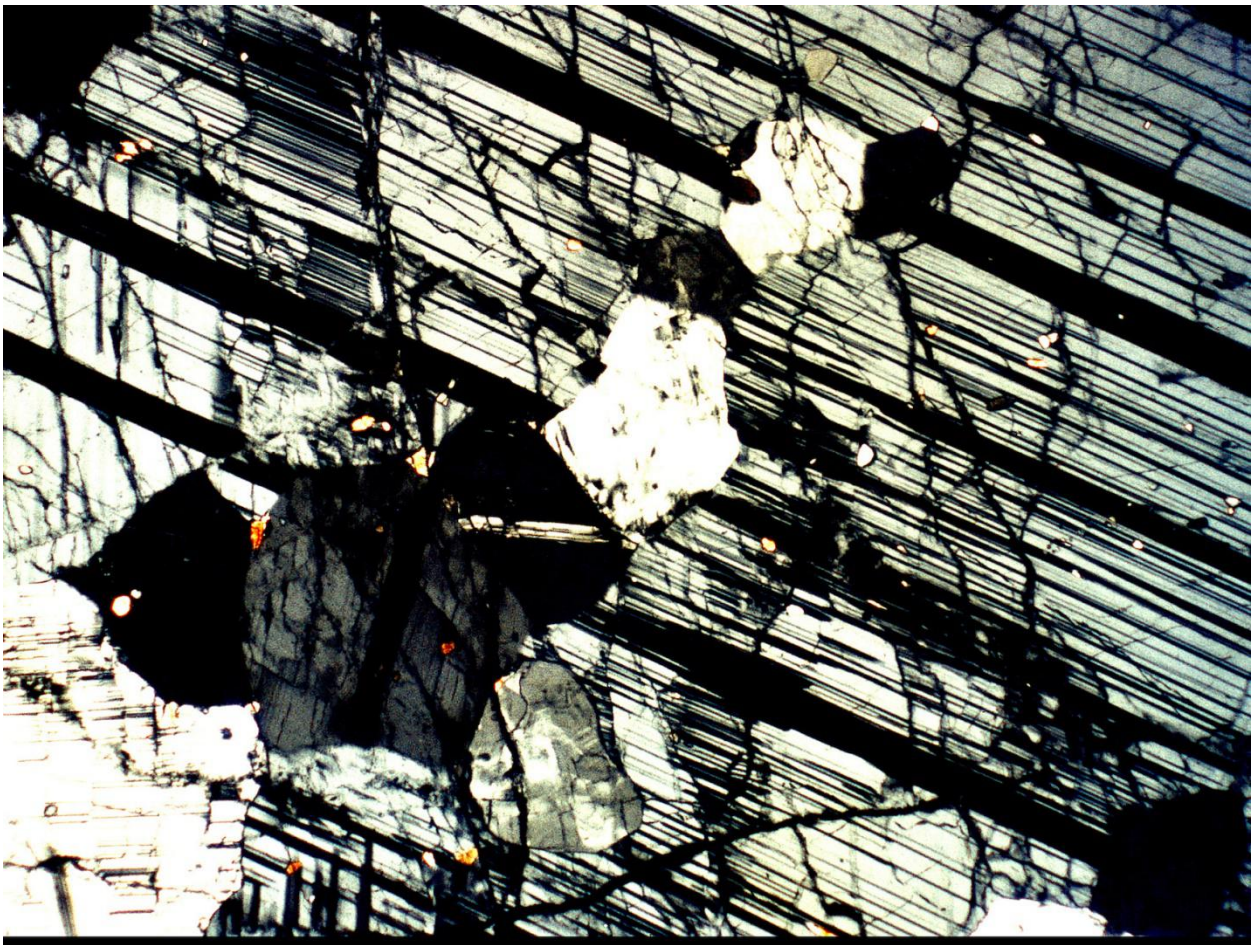


NASA

Mission Apollo 15
Sample 15015
Split 136
Photo Number JSC01892
Lithology regolith breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 2.85 mm
Magnification 2.5x
Source JSC

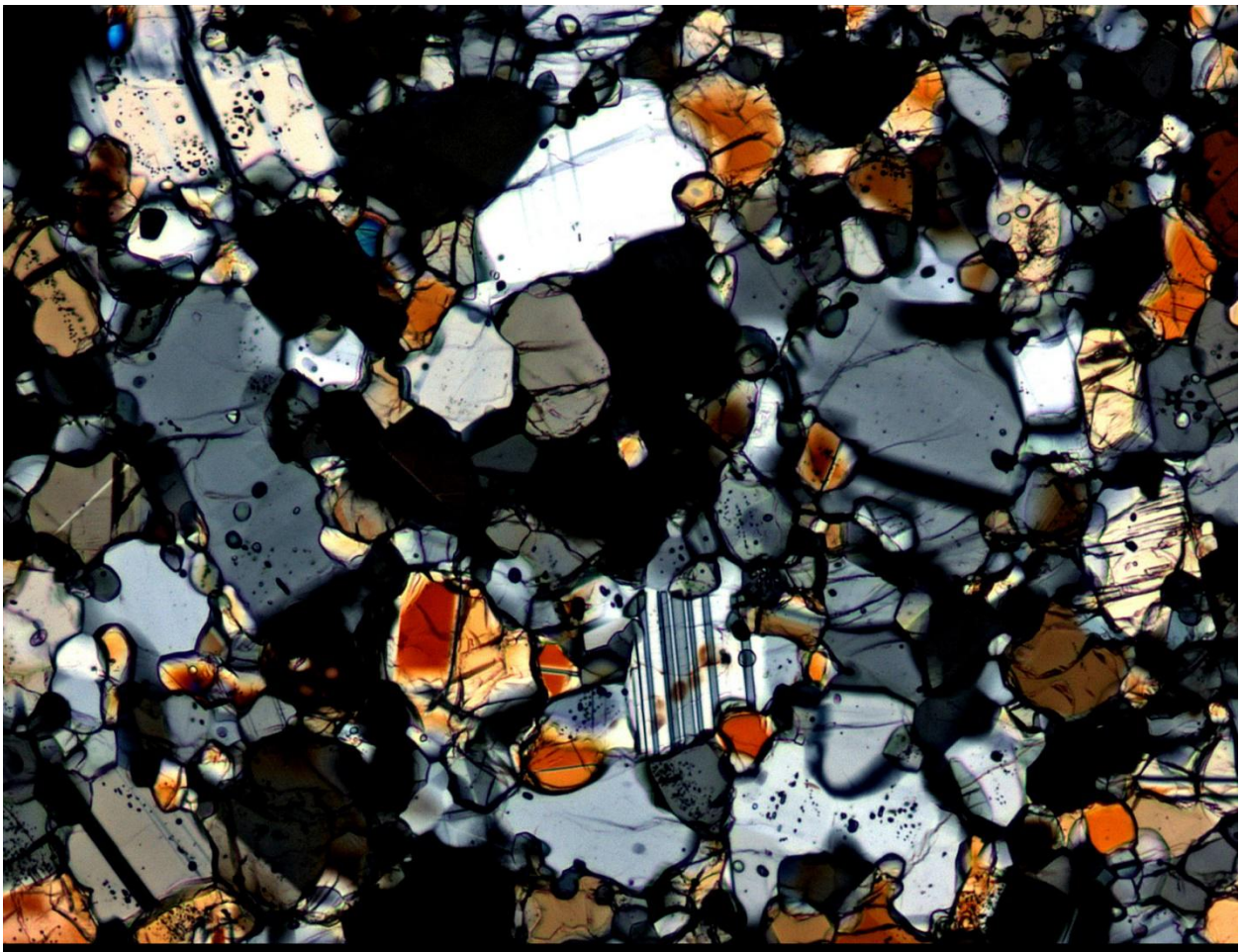


Mission Apollo 15
Sample 15016
Split 0
Photo Number S71-51740
Lithology basalt
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 2.85 mm
Magnification 2.5x
Source JSC



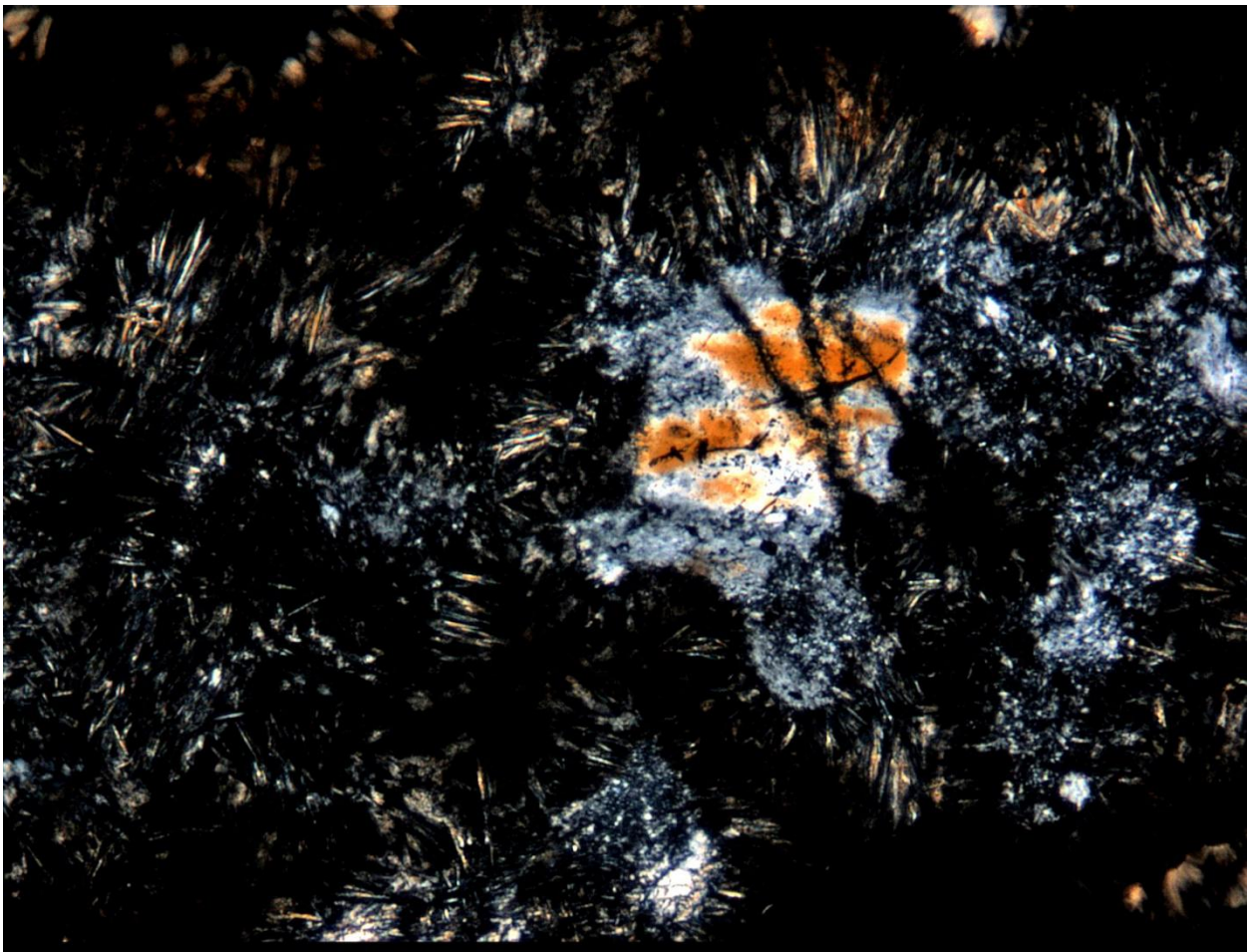
NASA

Mission Apollo 15
Sample 15415
Split 0
Photo Number S71-51779
Lithology anorthosite
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 2.85 mm
Magnification 2.5x
Source JSC



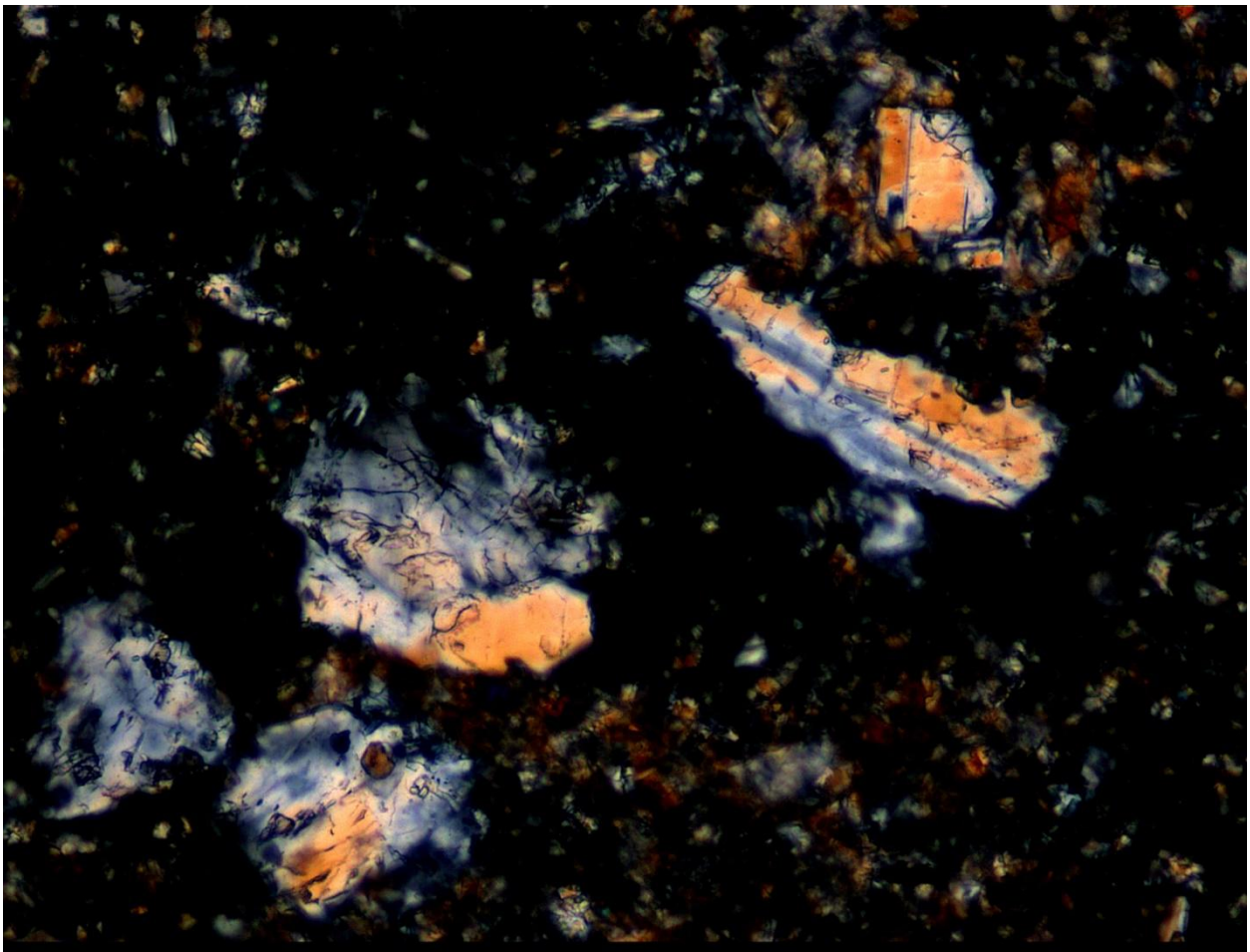
NASA

Mission Apollo 16
Sample 60016
Split 100
Photo Number JSC02381
Lithology fragmental breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 0.70 mm
Magnification 10x
Source JSC



NASA

Mission Apollo 16
Sample 60095
Split 29
Photo Number JSC08790
Lithology green glass vitrophyres
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 1.40 mm
Magnification 5x
Source JSC



NASA

Mission Apollo 16
Sample 60625
Split 7
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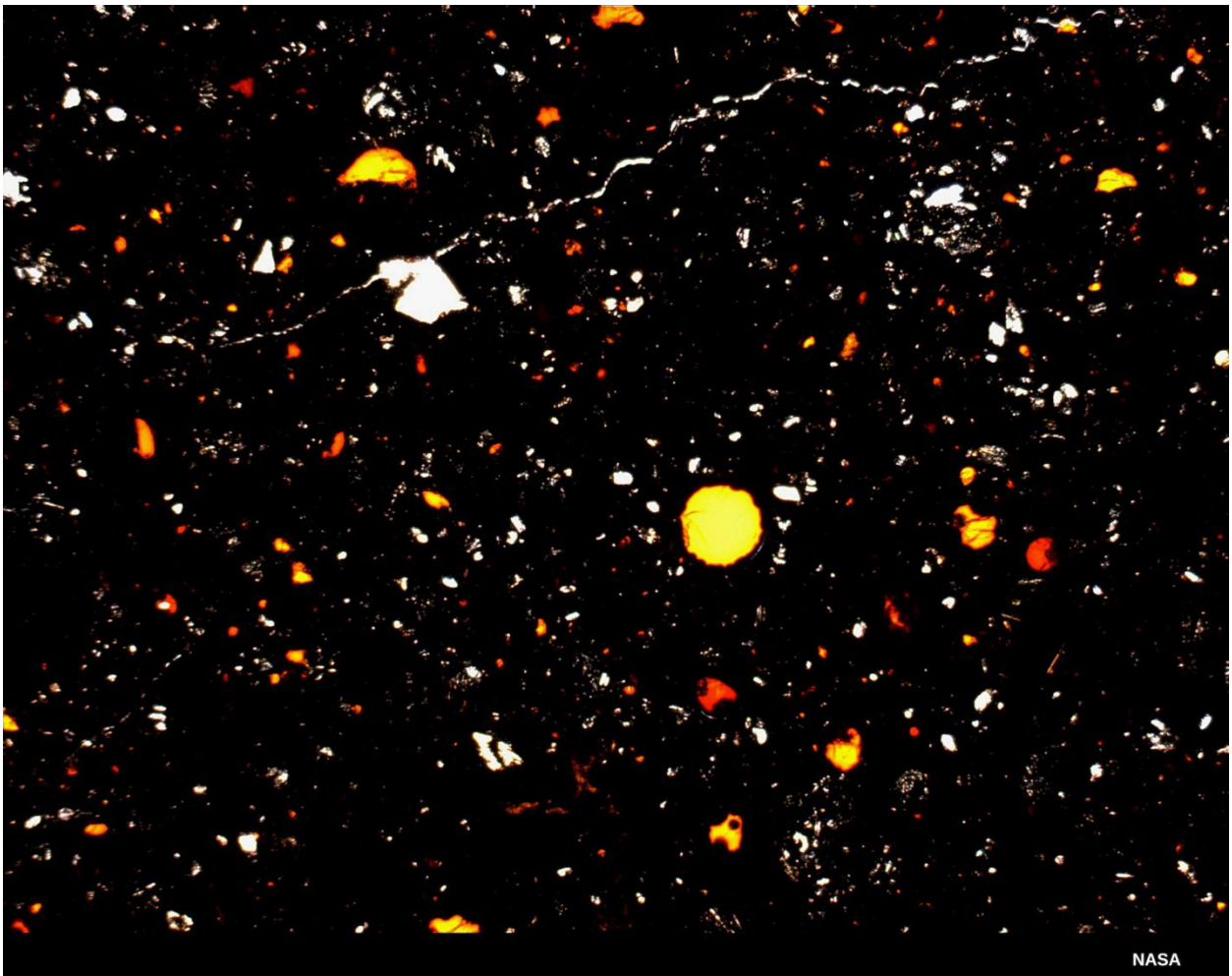
Lithology impact melt breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Field of View 0.70 mm
Magnification 10x
Source JSC



Mission Apollo 17
Sample 70175
Split 15
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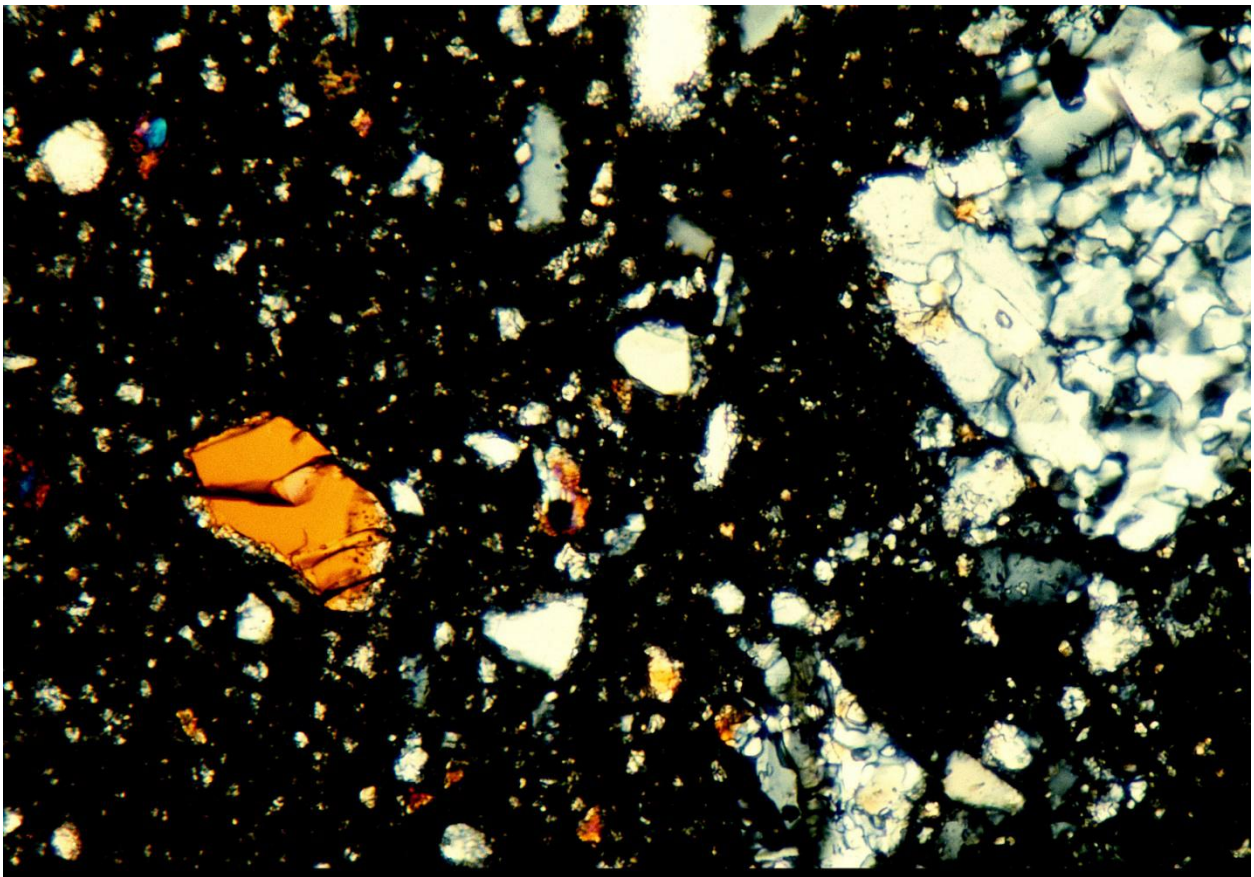
Lithology breccia
Image Type plane light microscope image
Thin Section Type standard thin section
Field of View 2.85 mm
Magnification 2.5x
Source JSC



Mission Apollo 17
Sample 72215
Split 188
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Lithology impact melt breccia
Image Type polarized light microscope image
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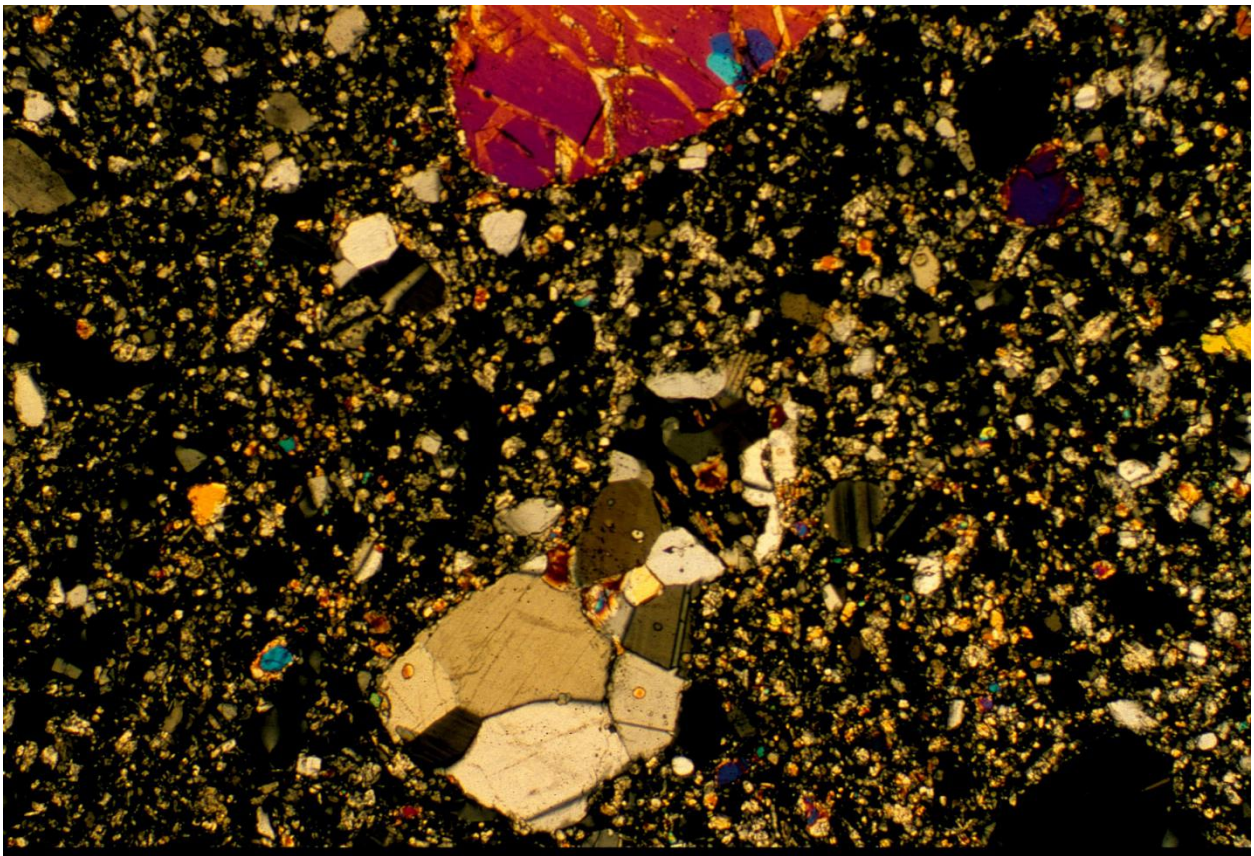
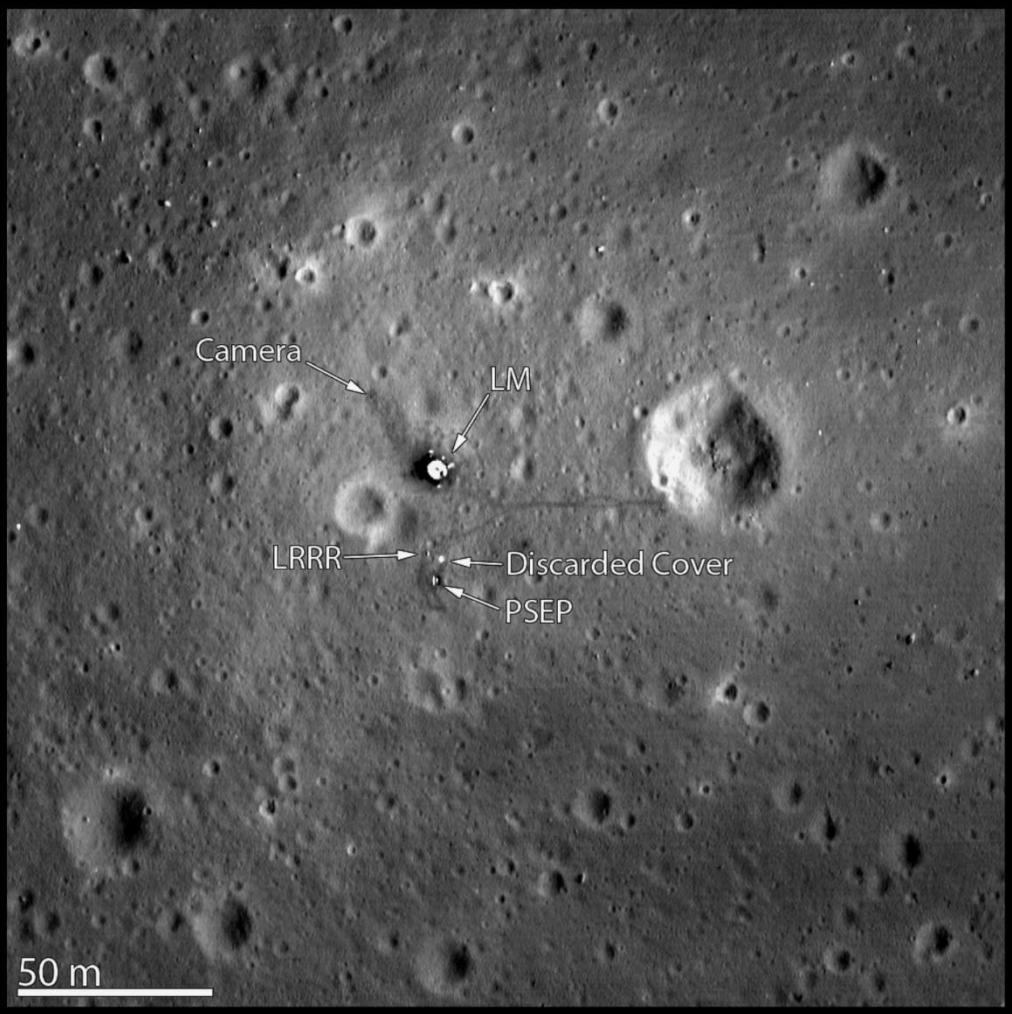
Field of View 600.00 mm
Magnification 10/1.25
Source G. Ryder



NASA

Mission Apollo 17
Sample 72395
Split 80
Photo Number ryder00288
Lithology impact melt breccia
Image Type polarized light microscope image
Thin Section Type standard thin section
Magnification 5x
Source G. Ryder

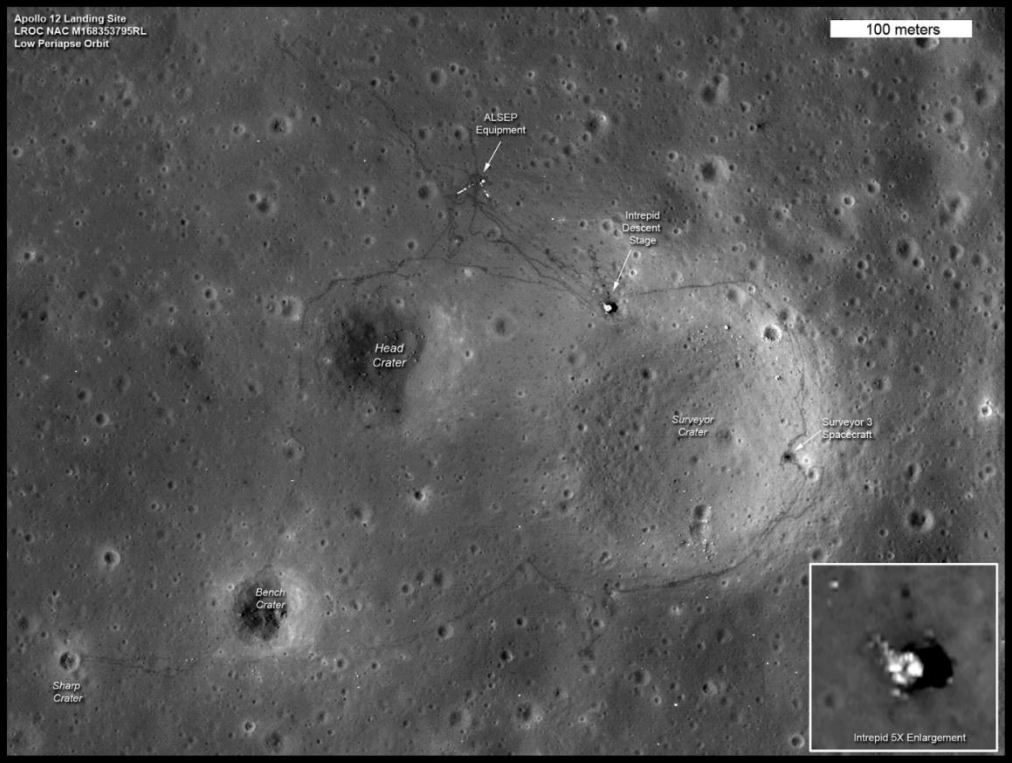
Apollo Landing Sites



Apollo 11

Neil Armstrong, Commander
Edwin E. Aldrin Jr., Lunar Module Pilot
Michael Collins, Command Module Pilot

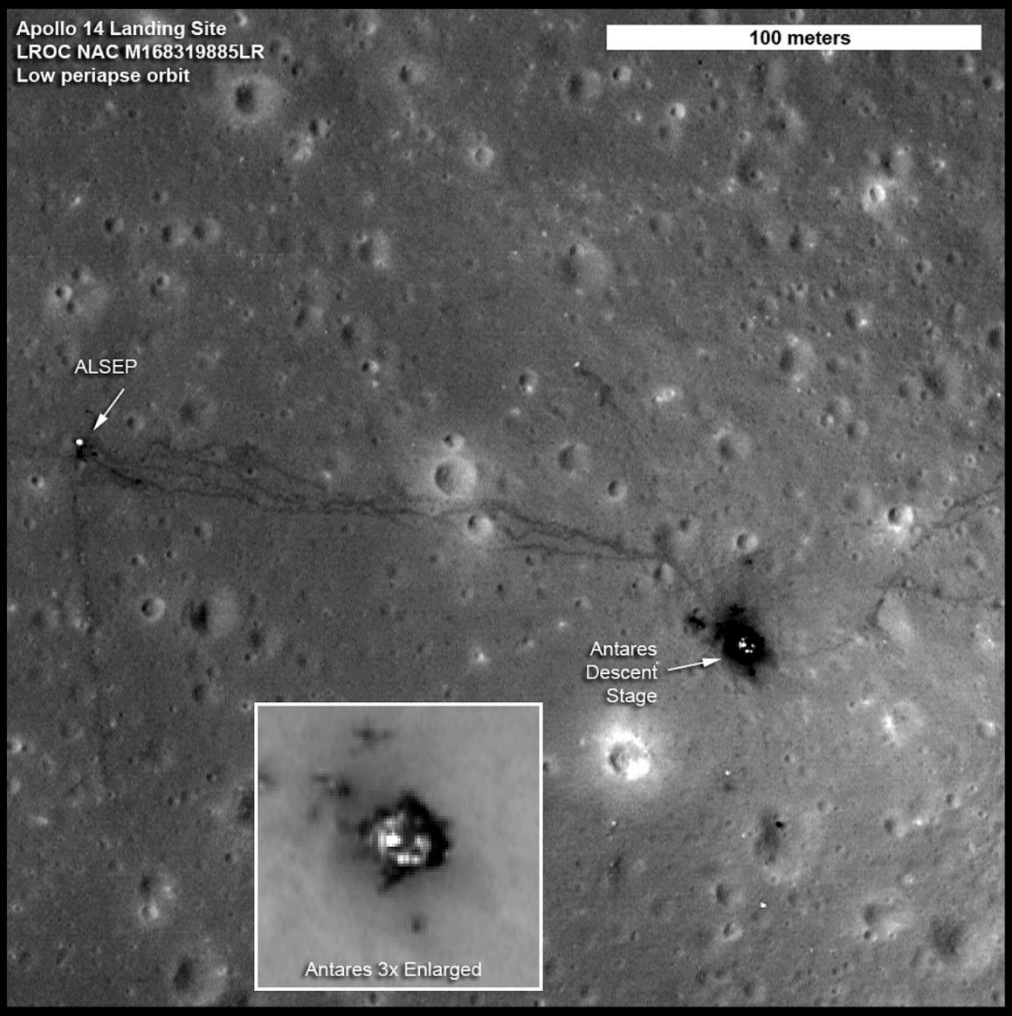
The primary objective of Apollo 11 was to complete a national goal set by President John F. Kennedy on May 25, 1961: perform a crewed lunar landing and return to Earth. Additional flight objectives included scientific exploration by the lunar module, or LM, crew; deployment of a television camera to transmit signals to Earth; and deployment of a solar wind composition experiment, seismic experiment package and a Laser Ranging Retroreflector. During the exploration, the two astronauts were to gather samples of lunar-surface materials for return to Earth. They also were to extensively photograph the lunar terrain, the deployed scientific equipment, the LM spacecraft, and each other, both with still and motion picture cameras. (NASA)



Apollo 12

Charles Conrad Jr., Commander
Alan L. Bean, Lunar Module Pilot
Richard F. Gordon Jr., Command Module Pilot

The primary mission objectives of the second crewed lunar landing included an extensive series of lunar exploration tasks by the lunar module, or LM, crew, as well as the deployment of the Apollo Lunar Surface Experiments Package, or ALSEP, which was to be left on the moon's surface to gather seismic, scientific and engineering data throughout a long period of time. Other Apollo 12 objectives included a selenological inspection; surveys and samplings in landing areas; development of techniques for precision-landing capabilities; further evaluations of the human capability to work in the lunar environment for a prolonged period of time; deployment and retrieval of other scientific experiments; and photography of candidate exploration sites for future missions. The astronauts also were to retrieve portions of the Surveyor III spacecraft, which had soft-landed on the moon April 20, 1967, a short distance from the selected landing site of Apollo 12. The flight plan for Apollo 12 was similar to that of Apollo 11, except Apollo 12 was to fly a higher inclination to the lunar equator and leave the free-return trajectory after the second translunar midcourse correction. This first non-free-return trajectory on an Apollo mission was designed to allow a daylight launch and a translunar injection above the Pacific Ocean. (NASA)



Apollo 14

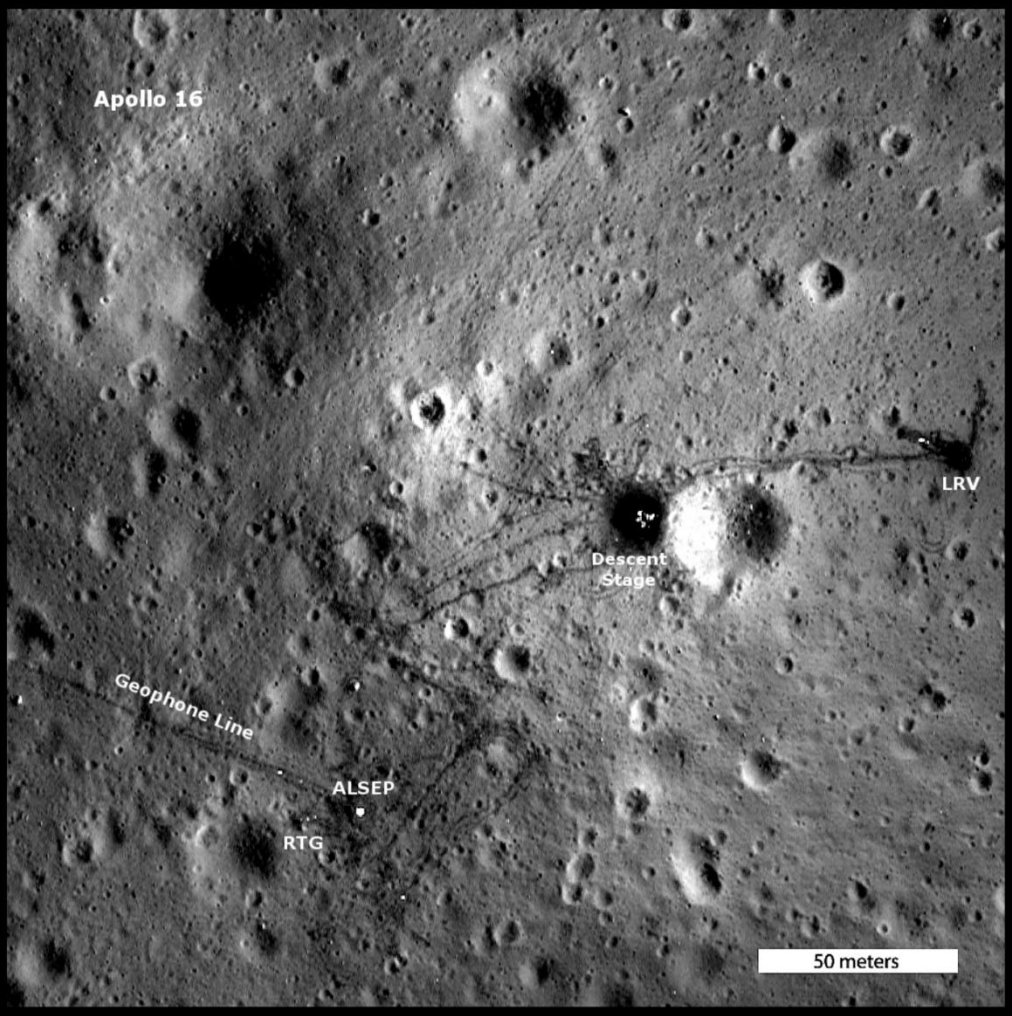
Alan B. Shepard Jr., Commander
Edgar D. Mitchell, Lunar Module Pilot
Stuart A. Roosa, Command Module Pilot

The primary objectives of this mission were to explore the Fra Mauro region centered around deployment of the Apollo Lunar Surface Scientific Experiments Package, or ALSEP; lunar field geology investigations; collection of surface material samples for return to Earth; deployment of other scientific instruments not part of ALSEP; orbital science involving high-resolution photography of candidate future landing sites; photography of deep-space phenomena, such as zodiacal light and gegenschein; communications tests using S-band and VHF signals to determine reflective properties of the lunar surface; engineering and operational evaluation of hardware and techniques; tests to determine variations in S-band signals; and photography of surface details from 60 nautical miles in altitude. (NASA)

Apollo 15

David R. Scott, Commander
James B. Irwin, Lunar Module Pilot
Alfred M. Worden, Command Module Pilot

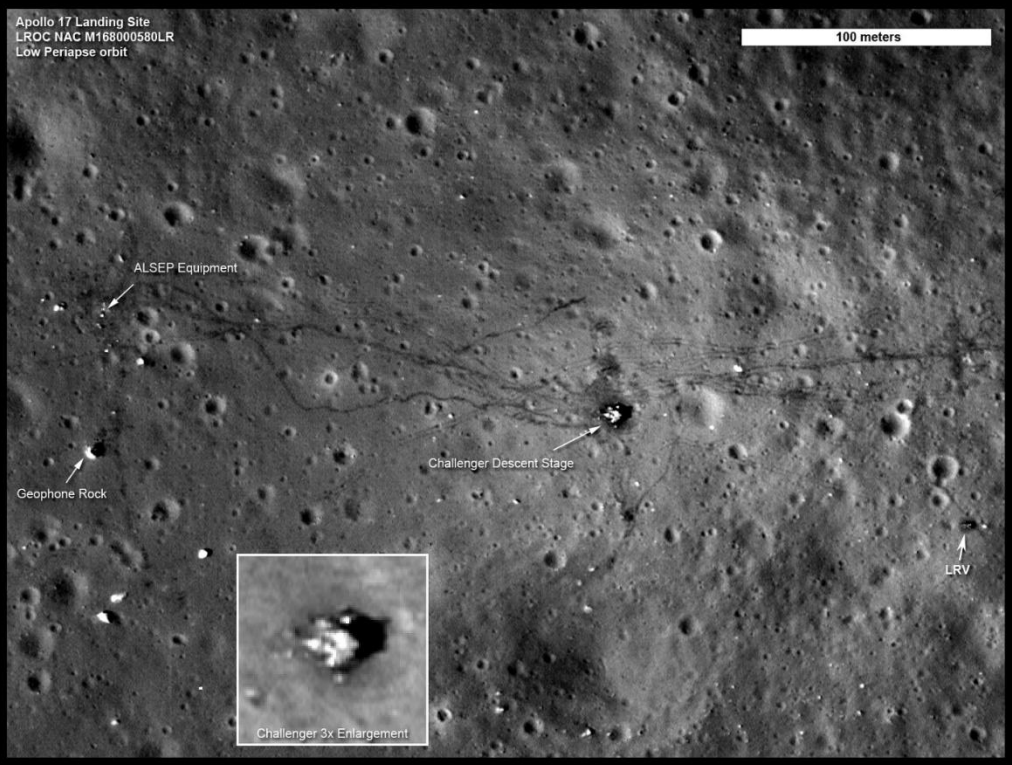
Apollo 15 was the first of the Apollo "J" missions capable of a longer stay time on the moon and greater surface mobility. There were four primary objectives falling in the general categories of lunar surface science, lunar orbital science and engineering-operational. The mission objectives were to explore the Hadley-Apennine region, set up and activate lunar surface scientific experiments, make engineering evaluations of new Apollo equipment, and conduct lunar orbital experiments and photographic tasks. Exploration and geological investigations at the Hadley-Apennine landing site were enhanced by the addition of the Lunar Roving Vehicle, or LRV. Setup of the Apollo Lunar Surface Experiments Package, or ALSEP, was the third in a trio of operating ALSEPs (on Apollos 12, 14 and 15). Orbital science experiments were concentrated in any array of instruments and cameras in the scientific instrument module, or SIM, bay. Engineering and operational objectives included evaluation of modifications to the lunar module, or LM, made for carrying a heavier payload and for a lunar stay time of almost three days. (NASA)



Apollo 16

John W. Young, Commander
Charles M. Duke, Jr., Lunar Module Pilot
Thomas K. Mattingly II, Command Module Pilot

Three primary objectives were (1) to inspect, survey, and sample materials and surface features at a selected landing site in the Descartes region; (2) emplace and activate surface experiments; and (3) conduct in-flight experiments and photographic tasks from lunar orbit. Additional objectives included performance of experiments requiring zero gravity and engineering evaluation of spacecraft and equipment. The Descartes landing site is in a highlands region of the moon's southeast quadrant, characterized by hilly, grooved, furrowed terrain. It was selected as an outstanding location for sampling two volcanic constructional units of the highlands – the Cayley formation and the Kant Plateau. Orbital science experiments were concentrated in an array of instruments and cameras in the scientific instrument module, or SIM, bay. A significant addition to surface objectives was an ultraviolet stellar camera to return photography of the Earth and celestial regions in spectral bands not seen from Earth. (NASA)



Apollo 17

Eugene A. Cernan, Commander
Harrison H. Schmitt, Lunar Module Pilot
Ronald E. Evans, Command Module Pilot

The lunar landing site was the Taurus-Littrow highlands and valley area. This site was picked for Apollo 17 as a location where rocks both older and younger than those previously returned from other Apollo missions, as well as from Luna 16 and 20 missions, might be found. The mission was the final in a series of three J-type missions planned for the Apollo Program. These J-type missions can be distinguished from previous G- and H-series missions by extended hardware capability, larger scientific payload capacity and by the use of the battery-powered Lunar Roving Vehicle, or LRV. Scientific objectives of the Apollo 17 mission included, geological surveying and sampling of materials and surface features in a pre-selected area of the Taurus-Littrow region; deploying and activating surface experiments; and conducting in-flight experiments and photographic tasks during lunar orbit and trans-earth coast. These objectives included deployed experiments, such as the Apollo Lunar Surface Experiments Package, or ALSEP, with a heat flow experiment; lunar seismic profiling, or LSP; lunar surface gravimeter, or LSG; lunar atmospheric composition experiment, or LACE; and lunar ejecta and meteorites, or LEAM. The mission also included lunar sampling and lunar orbital experiments. Biomedical experiments included the Biostack II experiment and the BIOCORE experiment. (NASA)