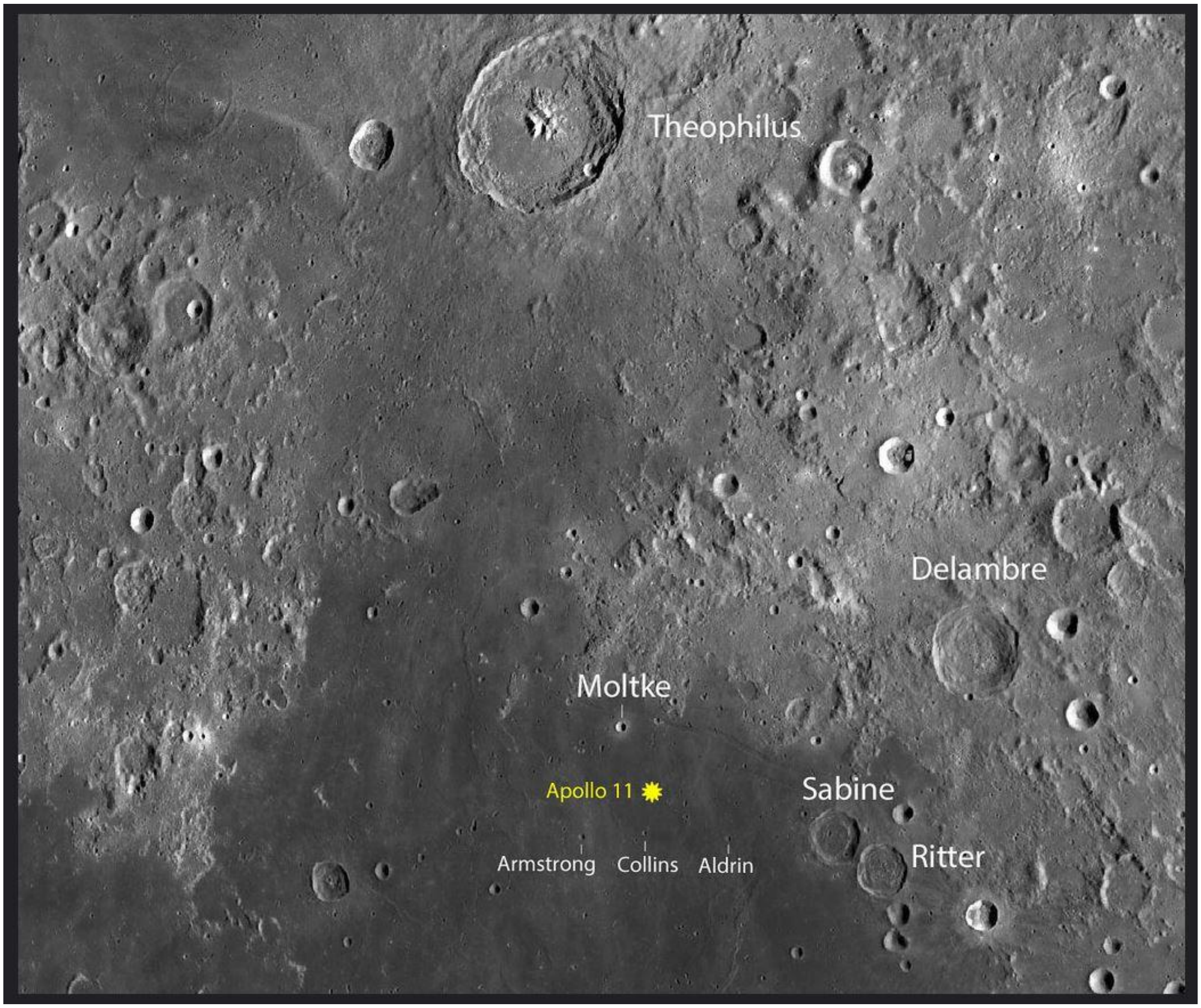
Apollo Lunar Landing Sites

The specific locations of the first two Apollo landing sites were selected mainly for reasons related to safety and orbital timing and partly for political reasons. In later missions, scientific objectives became an increasingly important factor. To enable direct communications and maximize safety, all six piloted Apollo landing missions were on the continuously Earth-facing side of the Moon because the farside terrain was not well known and because there were no relay satellites to enable continuous contact for a far-side landing. The Apollo landing sites were located relatively near the equator within what was known as the "Apollo Zone." This area had been studied extensively with telescopic images, and a near-equatorial landing would be most favorable for return-to-Earth trajectories. Landings had to be made during the lunar day on the near side in a way that would be favorable for the particular launch and orbital configuration and that would allow alternate site selection in the event of a launch delay. This combination of factors restricted the possible landing sites.

Both the Apollo 11 and Apollo 12 missions were targeted to land on smooth, flat mare surfaces deemed to have low numbers of impact craters. An eastern site was preferred for Apollo 11, which would leave a western site for backup, but too far east would require a night splashdown on the return to Earth. Mare Tranquillitatis was the only suitable landing site. The Apollo 12 site was selected to investigate a western mare region and, specifically, to land at a previous Surveyor site to demonstrate pinpoint landing accuracy. Apollo 12 landed within 160 meters (525 feet) of the Surveyor 3 spacecraft, within walking distance, and provided a clear demonstration of U.S. superiority in the space race with the Soviet Union.

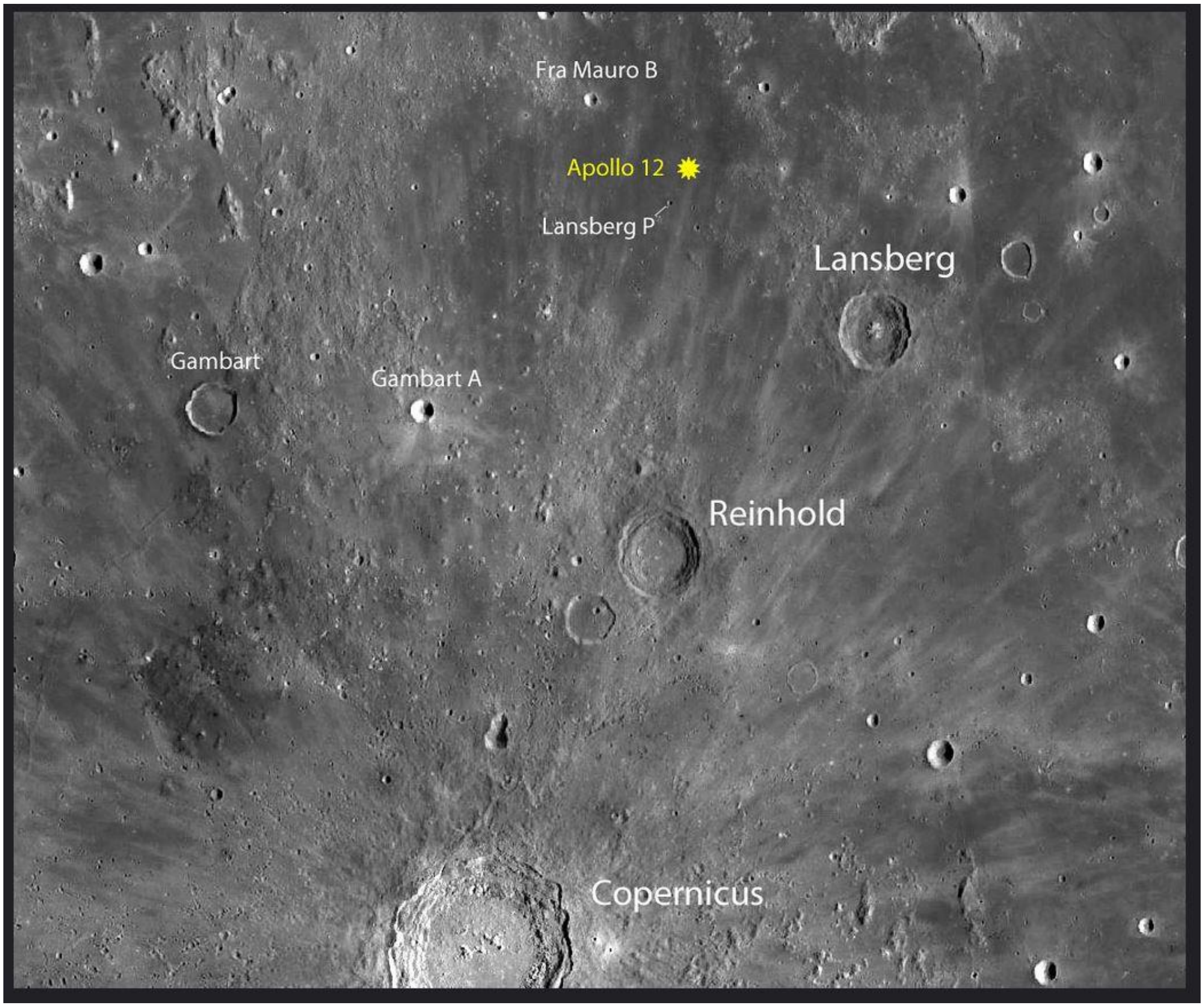
Apollo 11: First Manned Landing

The landing sites, once selected, were studied carefully beforehand using the results of Ranger, Surveyor, Lunar Orbiter and previous Apollo missions, and each had specific scientific goals. The Apollo 11 landing site would answer questions about the origin and composition of an old mare surface. Although the landed mission consisted of only one brief two and one-half hour extravehicular activity (EVA), during which 22 kilograms (48 pounds) of rock and soil samples were collected, the information contained in the samples was enormous. The dark materials that make up the mare were shown to be basalt, a common volcanic rock on Earth, and the ages of the basalts were found to be about 3.7 billion years old. The soils contained diverse rock types, including breccias, volcanic and impact glasses, and fragments of plagioclase -rich rock that were likely brought to the site by meteorite impacts into distant highlands. From these samples, it was deduced that the highlands were made of a rock type rich in plagioclase feldspar. These first lunar samples confirmed the Moon to be without water and lifeless. Surface experiments included setting up a solar-wind catcher, a seismometer to detect moonquakes, and a laser-ranging reflector for accurate determination of Earth-Moon distances.


Theophilus
Delambre
Moltke
Apollo 11
Sabine
Ritter
Armstrong
Collins
Aldrin

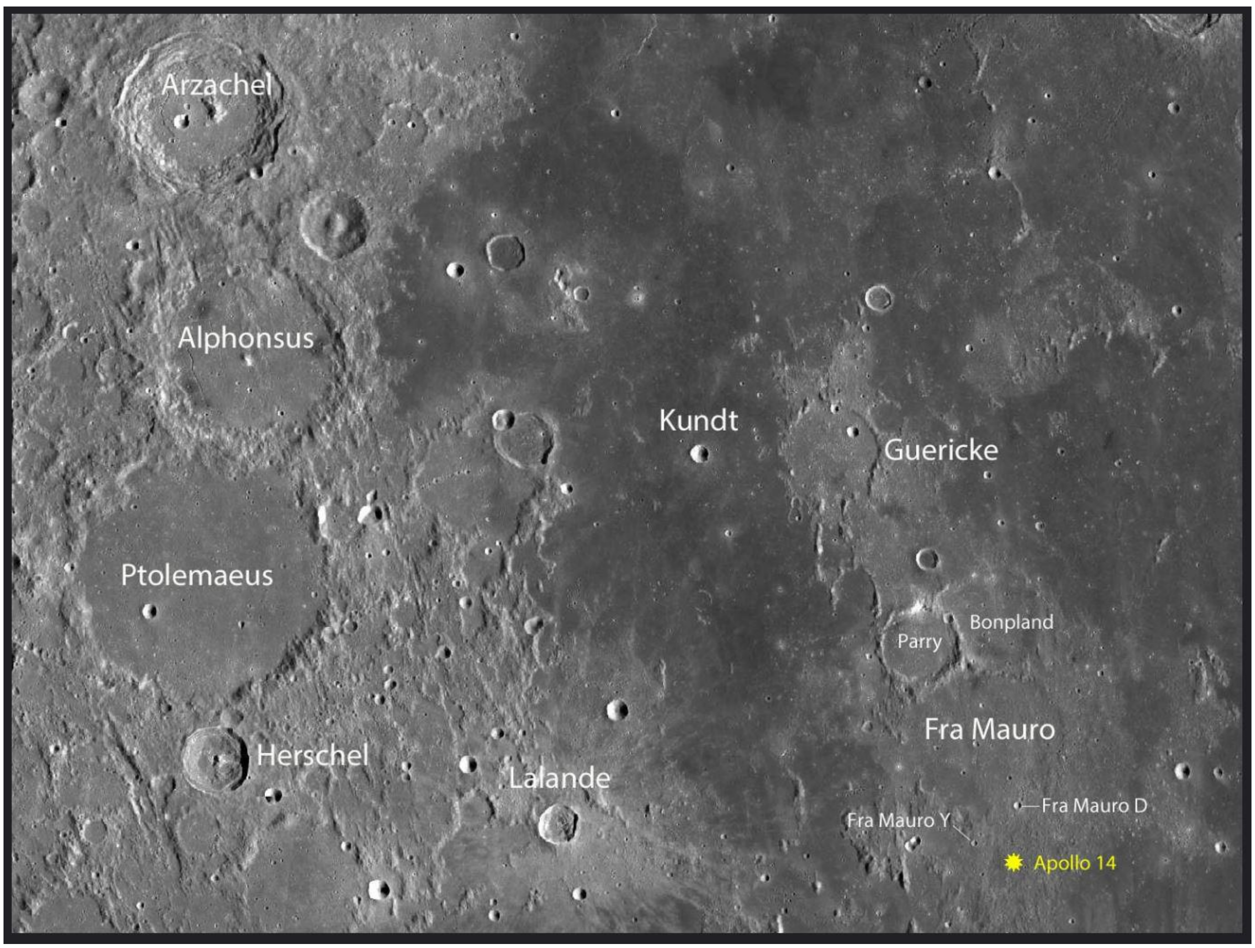
Apollo 12: Another Mare Site

The Apollo 12 (Surveyor 3) site was selected because it appeared to contain basalts of a different type and age. The site lay on one of the bright rays from the crater Copernicus, offering the chance to sample some of the ray material. The mission included two EVAs on foot and the setup of the first Apollo Lunar Surface Experiment Package, which included instruments to detect moonquakes, magnetic fields, solar wind and atmosphere. From analysis of the samples brought back from this mission, the basalts were found to be 3.15 to 3.35 billion years old, KREEP (material rich in K, REE, P, and other trace elements) was discovered, and the age of the crater Copernicus was determined to be about 800 million years.


Fra Mauro B
Apollo 12
Lansberg P
Lansberg
Gambart
Gambart A
Reinhold
Copernicus

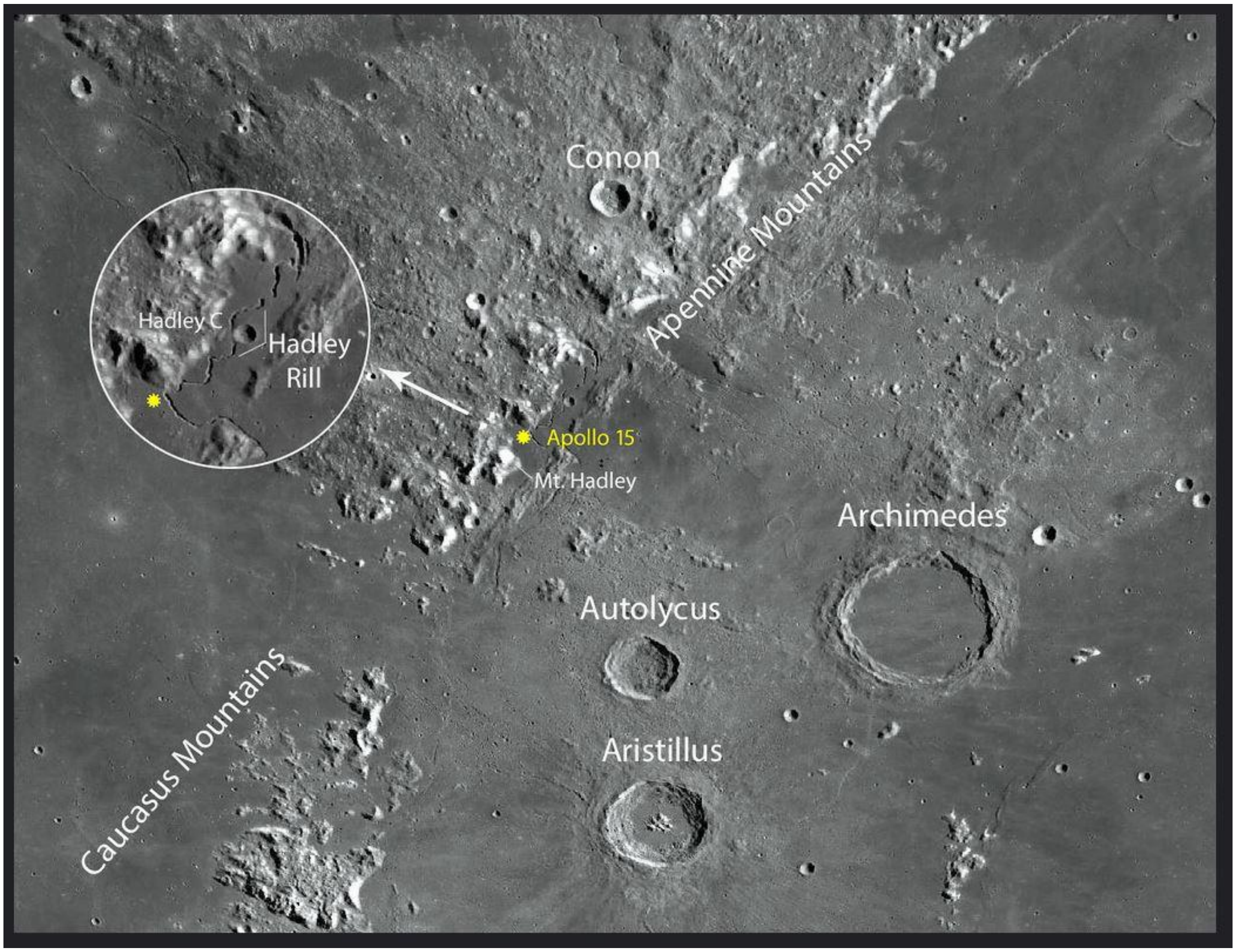
Apollo 14: The Fra Mauro Highlands

An area on the rough highlands north of Fra Mauro Crater was chosen as the Apollo 14 site. The intent was to investigate the Fra Mauro Formation, thought to be material ejected by the Imbrium Basin impact. This material would potentially provide a date for the Imbrium event and a sample of rocks from deep within the Moon's crust. Two EVAs were conducted on foot, 43 kilograms (95 pounds) of samples were collected, and an active seismic experiment was accomplished. Most of the rocks found during this mission are complex impact-melt breccias, likely formed by the Imbrium impact, and most of the rock ages indicate that the Imbrium event occurred 3.85 billion years ago.



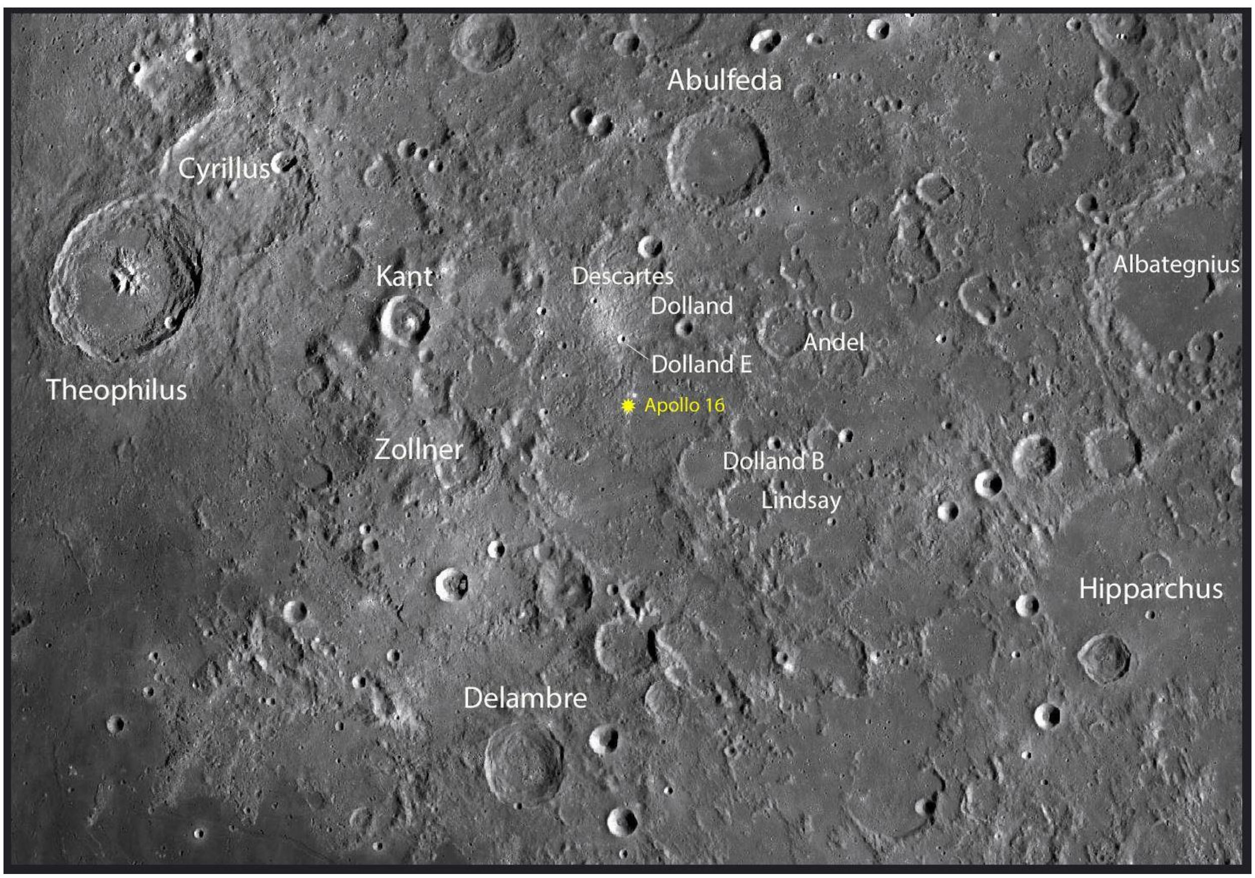
Apollo 15: Imbrium Basin, Volcanic Features, and Ancient Highlands

The Apollo 15 site was located at the edge of Mare Imbrium at the foot of the mountains forming its main topographic ring. This geologically complex site provided for investigation of Mare Imbrium, the Apennine Mountains, and a long channel-like feature called Hadley Rille. Apollo 15 brought along the first Lunar Roving Vehicle (such vehicles were also used during the Apollo 16 and 17 missions). This site was the farthest north of the six landed missions, and it provided the third leg of a triangle for the seismic and laser-ranging arrays. The dark rocks were found to be volcanic basalt, not impact melt, and their 3.2 billion year ages meant that they were not caused directly by the Imbrium impact and did not fill the basin for nearly 600 million years after the basin formed. The rille was determined to be an ancient lava channel. Green volcanic glass beads, formed hundreds of kilometers deep in the lunar mantle, were found at the site, and the first large rock sample of anorthosite, the so-called genesis rock, 15415, was collected. Seismic data indicated a crustal thickness of 50 to 60 kilometers (31 to 37 miles).


Conon
Apennine Mountains
Hadley C
Hadley
Rill
Apollo 15
Mt. Hadley
Archimedes
Autolycus
Aristillus
Caucasus Mountains

Apollo 16: Young Volcanic Rocks?

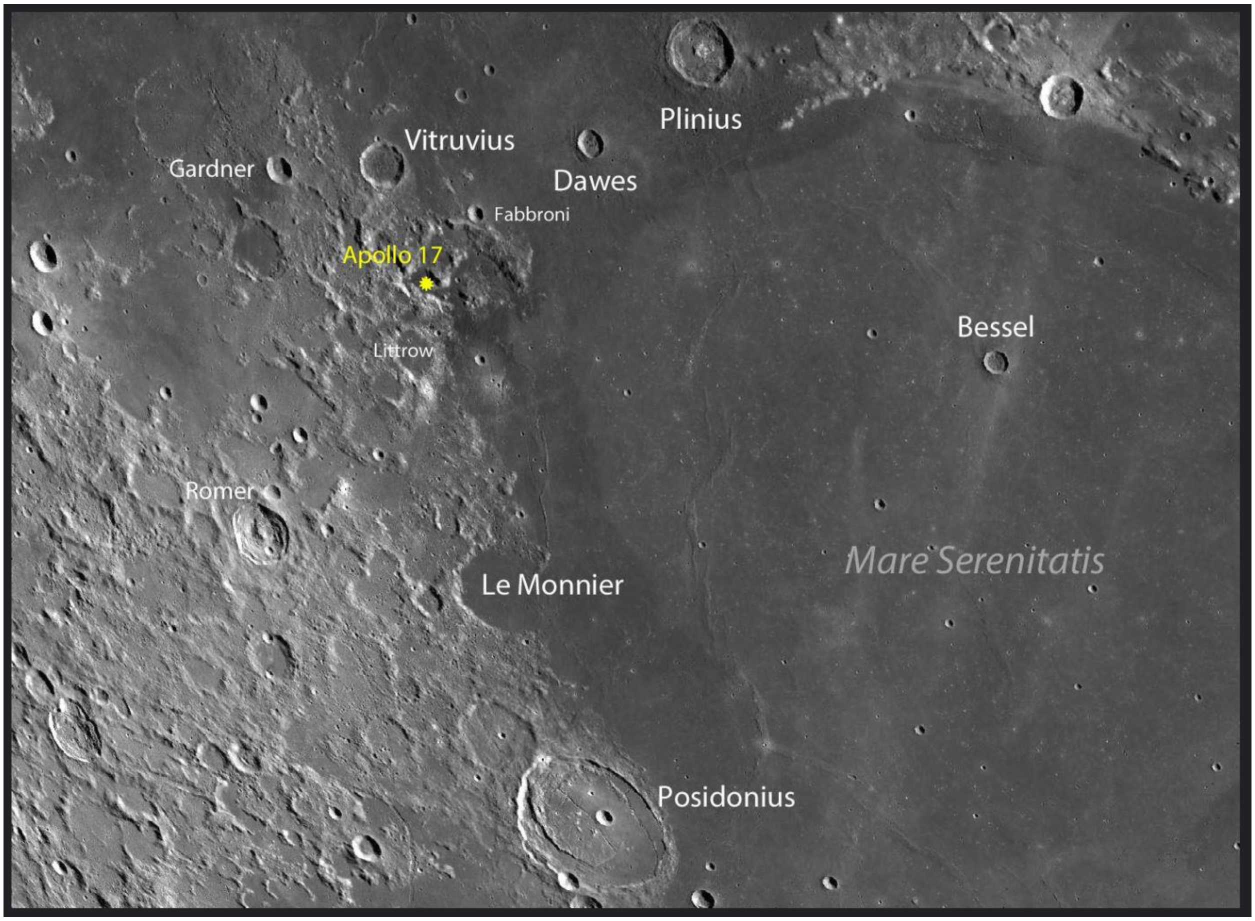
Apollo 16 targeted the lunar highlands, away from the basalt-filled basins. The main objectives were to determine the age of the highlands and whether they were volcanic. A site was selected along the edge of the smooth Cayley Plains adjacent the Descartes Mountains so as to explore and sample both features. The site contained two small, fresh craters that penetrated the surface formations and that provided natural drill samples of the underlying materials. To the surprise of mission planners, none of the samples were volcanic; most were complex breccias, formed by numerous, large impact events. Although the breccias dated from 3.8 to 4.2 billion years, they contained pieces of very ancient anorthosites from the earliest lunar crust.



Apollo 17: The Taurus Littrow Valley

The Apollo 17 landing site, like the Apollo 15 site, was chosen to be at the interface between a mare and a highland region. The Taurus Littrow Valley, along the southeastern edge of Mare Serenitatis, was selected to investigate the age of the basin, the different kinds of highland landforms surrounding the basin, the basalts that filled the basin, and the dark mantling materials thought potentially to be young volcanic ash deposits. Also, craters in the Taurus-Littrow Valley floor were thought to be secondary craters from the Tycho event, providing the possibility of sampling Tycho ejecta and dating the impact.

Exposure ages of the central valley craters indeed indicated a "young" age of about 109 million years, apparently corresponding to the Tycho event. The highland mountains were found to be a mixture of older feldspathic crustal materials and impact melt formed by the Serenitatis impact, about 3.87 to 3.9 billion years ago. The close dates of the major impact basins suggested that the Moon experienced a late, heavy bombardment of large impactors around 3.8 to 4 billion years ago. Orange and black volcanic ash deposits, 3.5 billion years old, were found in the regolith and were observed by the astronauts in the surrounding regions from orbit. Evidence of young volcanism was not found, but some of the oldest crustal rocks, dunites and troctolites with ages between 4.3 and 4.5 billion years, were discovered along with the impact breccias.


Plinius
Vitruvius
Gardner
Dawes
Fabbroni
Apollo 17
Bessel
Littrow
Romer
Mare Serenitatis
Le Monnier
Posidonius

My Thoughts on Apollo Landing Sites

I did an internet search and found the discussion I included in this document. I found reading about each landing site interesting. Many of the reasons for site selection I didn’t know.

I did know that all the sites were on the near side of the moon. The landing time was during lunar morning to help with heat building in the suits and lunar module.

I knew one reason the Apollo 11 site was chosen and that was the lack of craters and such that might cause landing on the surface difficult and possibly topple the lunar lander over.

I did know that starting with Apollo 12, the precision of landing in a certain spot was perfected, so that opened up a lot of other landing sites on the moon. I don’t know if all the Apollo sites had been predetermined but this precision landing allowed the planners to consider more difficult sites with interesting geology to explore to be chosen.

I can see by the images that Apollo 12 was on a ray system. I can see why this choice of finding material that was ejected from some impact from below the lunar surface important.

The remaining landing sire reasons I could have only guessed at. It was nice to read these descriptions and understand the science behind why each site was chosen.

References:

1) *How to See All Six Apollo Moon Landing Sites* – Sky & Telescope - https://skyandtelescope.org/observing/how-to-see-all-six-apollo-moon-landing-sites/
2) *Apollo Lunar Landing Sites | Encyclopedia.com* - https://www.encyclopedia.com/science/news-wires-white-papers-and-books/apollo-lunar-landing-sites#:~:text=Apollo%20Lunar%20Landing%20Sites%20The%20specific%20locations%20of,missions%2C%20scientific%20objectives%20became%20an%20increasingly%20important%20factor