

= Fra Mauro formation =

The Fra Mauro formation (or Fra Mauro Highlands) is a selenological formation on the near side of Earth 's Moon that served as the landing site for the American Apollo 14 mission in 1971 . It is named after the 80 @-@ kilometer @-@ diameter crater Fra Mauro , located within it . The formation , as well as Fra Mauro crater , take their names from a 15th @-@ century Italian monk and mapmaker of the same name . Apollo 13 was originally scheduled to land in the Fra Mauro highlands , but was unable due to an in @-@ flight technical failure .

Fra Mauro is thought to have been formed from ejecta , or debris , from the impact which formed Mare Imbrium . During Apollo 14 , the crew members sampled ejecta from Cone crater , a feature close in proximity to the immediate landing site of the mission , which provided insight into the composition of material deep inside the formation . Data from the mission has helped to determine the approximate age of Mare Imbrium , suggesting that it is no more than about 4 @.@ 25 billion years old .

= = Formation and geography = =

Fra Mauro is a widespread hilly geological area covering large portions of the lunar surface around Mare Imbrium , and is thought to be composed of ejecta from the impact which formed Imbrium . The area is primarily composed of relatively low ridges and hills , between which exist undulating valleys . Much of the ejecta blanket from the Imbrium impact is covered with debris from younger impacts and material churned up by possible moonquakes . Debris found in the formation may have originated from deep beneath the original crust , and samples collected there could give insight into the geologic history of the Moon . The petrology of the formation , based on data obtained on Apollo 14 , indicates a history of impact and ejection possibly spanning over approximately 500 million years .

A relatively recent impact created Cone crater , 1 @,@ 000 feet across and 250 feet deep , near the landing site of Apollo 14 . One of the main objectives of that mission was to sample the original Imbrium material located on its rim .

Samples obtained of the Fra Mauro formation during Apollo 14 suggest that the impact that formed the Imbrium basin is no older than 4 @.@ 25 billion years .

= = Geology = =

Analysis of Apollo 14 samples suggests that there are five major geologic constituents present in the immediate landing area : regolith breccias , fragmental breccias , igneous lithologies , granulitic lithologies , and impact @-@ melt lithologies . Samples of each of these compositions were recovered in one or both of two major surface units of the Apollo 14 landing site within Fra Mauro : the immediate impact blanket of Cone crater , about 25 million years old , and surrounding older terrain .

During Apollo 14 , astronauts Alan Shepard and Edgar Mitchell recovered ejecta material from the Cone crater impact , which is believed to have excavated Imbrium impact material from a possible depth of about 80 m (260 ft) . Most of the samples returned from the Moon from Fra Mauro are classified as breccias from the vicinity of Cone crater .

Studies conducted upon samples from Apollo 14 have shown that the samples do not support the possibility that the landing site is floored by volcanic rocks , or basalts . Basalts are sparse in samples of Cone crater ejecta , but somewhat abundant in samples recovered farther west , on the opposite side of the immediate landing site . Two explanations have been presented for this : (1) the majority of basalt in the landing site lies below the depth of excavation of Cone crater or (2) the presence of a basalt flow beneath the landing area excavated by a nearby crater with a diameter of 100 m (330 ft) . It is believed that the former seems more likely , as the basalts are similar to the basalts recovered at Cone crater . It is inconclusive whether or not the recovered basalts have a direct affiliation with the landing site , as it is located in a valley between ridges , and there exists the

possibility that the basalts were merely deposited there as a result of other impact events .

The Apollo 14 crew members sampled boulders in the ejecta of Cone crater . These boulders appeared to be layered and fractured breccias , contrasting from the appearance of the surrounding area because of their older age . As these boulders increase in size and number closer to Cone crater , it is believed that they originate from the greatest depth of excavation of Cone crater . These boulders show what is believed to be general characteristics of the Fra Mauro formation : clastic texture , stratification , and jointing or fracturing .

= = Landing site selection = =

As Apollo 14 was an early Apollo mission , landing sites were restricted to equatorial regions for technical reasons . After Apollo 12 demonstrated the ability to land at a pre @@ specified landing zone , mission planners considered landings in rough , but geologically interesting areas of the Moon .

The aborted Apollo 13 mission was originally scheduled to land at Fra Mauro , with Apollo 14 scheduled to land in the Littrow region of Mare Serenitatis . After Apollo 13 failed to land , it was decided to re @@ target Apollo 14 to Fra Mauro , as it was regarded as more interesting scientifically than the Littrow site . There , Apollo 14 had the objective of sampling ejecta from the Imbrium impact to gain insight into the Moon 's geologic history . A landing site near the freshly formed Cone crater was chosen , as this crater served as a ' natural drill hole ' to allow the astronauts to obtain Imbrium ejecta , the primary objective of the mission .