Geology and Petrology of the Apollo 15 Landing Site: Past, Present, and Future Understanding

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The Apollo 15 Landing Site

On July 30, 1971, the Apollo 15 lunar module *Falcon* passed over the 4000 m Apennine Mountain front and landed at one of the most geologically diverse sites selected in the Apollo program, the Hadley-Apennine region. Although this event occurred 14 years ago, its unique nature makes the site an important target of continued scientific investigation.

Commander Dave Scott and pilot Jim Irwin descended onto a mare plain just inside the most prominent mountain ring structure of the Imbrium Basin, the Montes Apennines chain that marks its southeastern topographic rim (Figure 1), close to the sinuous Hadley Rille. The main objectives of the mission were to investigate and sample materials of the Apennine Front itself (expected to be Imbrium ejecta and pre-Imbrian materials), of Hadley Rille, and of the mare lavas of Palus Putredinis (see cover). A package of seven surface experiments, including heat flow and passive seismics, was also set up, and 1152 surface photographs were taken. More information was provided by a television camera, data acquisition (sequence) camera, orbital photographs, and orbital chemical data. Apollo 15 was the first Apollo mission devoted almost entirely to science and was the first to use a Rover vehicle, which extended the length of the traverses considerably, from a total of 3.5 km on Apollo 14 to 25.3 km during the three separate traverses on Apollo 15 (Figure 2). Sample mass was almost doubled, from 43 kg on Apollo 14 to 78 kg on Apollo 15.

The Apollo 15 mission was very successful, despite a reduction in planned traverse length necessitated in part by unexpected and time-consuming difficulties in the collection of the deep core sample (at the experiments package site). Thus the North Complex, a hilly, cratered region of disputed origin, was not visited. The mission results and preliminary analyses were reported in the Apollo 15 Preliminary Science Report (*National Aeronautics and Space Administration* (NASA), 1972) and in several papers published in a special section in *Science* (January 28, 1972). These reports were written within 4 months of splashdown, but they still form the largest coherent set of interpretations of the landing site. A volume of abstracts, unrelated to any meeting, on results of sample studies was also published (*Chamberlain and Watkins*, 1972).

Outline of Results: 1970’s

The Apollo 15 mission produced both expected and unexpected results. The observations were consistent with Hadley Rille being a collapsed lava tube or channel (*Greeley*, 1971; *Howard et al.*, 1972). The west rim is about 30 m lower than the east rim, and the rille walls expose layered outcrops in the upper 60 m, with talus below (Figure 3). The rille trends northeast and then west over 120 km in a valley between the Apennine scarp of the Imbrium Basin and the large terrain slump blocks from the front (see cover). It is almost completely confined within mare material, although the source crater straddles mare and highlands deposits (*Greeley*, 1971; *Carr and Ehl-Baz*, 1971). At the Apollo 15 site, regolith (soil) thins to vanishing at the rille edges, and mare basalts were sampled almost in place. Dark elevated benches along the bases of the mountains and terraces within the mare plains suggest that lavas may have ponded, drained, and subsequently subsided by as much as 300 m (*Swann et al.*, 1972; *Howard et al.*, 1972). The astronauts collected many mare basalts, which form two main chemical groups of the same age (3.5 b.y.), isotopic characteristics, and rare-earth element (REE) patterns (Figure 4). One group, olivine-normative, contains many vesicular basalts and shows an olivine fractionation trend. The other group, quartz-normative, is pigeonite-phryic and includes both vitrophyric and coarse-grained examples but shows little evidence of fractionation.

The Apennine Front samples include a variety of highland materials, ranging from slowly cooled igneous rocks such as ferroan anorthosites (e.g., the so-called “Genesis rock” 15415, discussed below), nortites (Figure 5a), and spinel-bearing troctolites, to impact melts and metamorphosed breccias (breccias consist of broken fragments in a fine-grained matrix, which on the moon are produced by impacts). Unexpectedly, however, distinctly highland samples are rare and generally small; most of the Apennine Front samples are regolith breccias containing little obvious highland material. The overall texture is in fact rather smooth, lacking large boulders. Only three meter-sized boulders were close enough to the planned traverses to sample, and two of them (represented by samples 15403 at station 6A and 15205 at station 2) are post-Imbrian esoxites. Sample 15445 was lying next to the third boulder at station 7; the sample is macroscopically similar to the boulder and was probably slumped from it. It is a highlands impact melt, possibly from the Imbrium Basin itself, containing samples of rocks that crystallized slowly at depth within the crust (*Ryder and Bowser*, 1977).

The average composition of the Apennine Front, as suggested by chemical mixing models of the regolith and by the composition of impact glasses in it, is a low-K KREEP (K, REE, P, and other incompatible element enriched) basaltic composition (rare earths of 50 x chondrites; low-K Fra Mauro, or "LKFM," see Figure 4). Several impact melts, including 15445, have this general composition, which has never been found as a pristine igneous rock type. The conspicuous component of the common brown glassy regolith breccias on the Apennine Front is spherical emerald green glass, an unexpected find. After early thoughts that the green glass was impact melt from the Imbrium Basin [e.g., *Quaide*, 1973; *Dence et al.*, 1974], it was later generally recognized that green glass is a volcanic fire fountain product (e.g., *Delano*, 1979). The green glass is indistinguishable in age from the local mare basalts but is much more magnesium and cannot be related to them by melting or crystallization processes. While present in all regolith samples, it is most common on the Apennine Front, where some samples are almost pure green glass clods. Ubiquitous but sparse red (13.8% TiO₂) and yellow (3.5% TiO₂) glasses have also since been recognized as volcanic (*Delano and Lavo*, 1981).

Another unexpected discovery was the common occurrence of volcanic KREEP basalts (Figures 4 and 5b), although only as small fragments. They are ~3.85 b.y. old, an age at present indistinguishable from that of the Imbrium Basin, and ubiquitous throughout the site.

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A More Detailed Look at the Present Picture and Problems

Closely spaced and conjugate lineament patterns were observed and photographed on the Apennine Front massifs. These patterns appear to be artifacts of oblique solar illumination [Wolfe and Bailey, 1972]. However, apparent benches in Silver Spur are probably reflective of structure or layering within the massif.

The above summary presents only a glimpse of essential results of the Apollo 15 mission. An understanding of the scientific implications and problems requires a more detailed examination of the impressive stratigraphic section and samples, ranging from pre-Imbrian to Copernican. The Apollo 15 mission has often been thought to have received short shrift ("the forgotten mission"), and its geology and samples remain less well known than those of the Apollo 16 and 17 landing sites. A recent interpretation of the geology is summarized in the cross section in Figure 6.

Highland Material and the Apennine Front

The primary highland sampling objective of the Apollo 15 mission was to characterize the Imbrium Basin ejecta and possibly a section of pre-Imbrian basin materials exposed within the Apennine scarp, with the hope of identifying "primordial" crustal or subcrustal materials. Analytical targets were the petrology, chemistry, and shock levels of Imbrian ejecta, the detection of basin impact melt, and the radiometric dating of Imbrian-related samples to compare with results from the Apollo 14 mission, which landed further out radially on Imbrian ejecta, and to establish the absolute age of the Imbrian impact. Such analyses could constrain theories of the origin of multiringed basins by their implications for the location, dimensions, and ejecta properties of the original Imbrian crater. The Imbrium Basin is one of the largest and youngest of the large lunar basins and has strongly influenced the geology of the Apollo 15 landing site. Two pre-Imbrian basins, Serenitatis and Insularum, the latter an old degraded basin centered near Copernicus [Wilhelms and McCauley, 1971; Head, 1977], affect the site's topography and probably contributed material to the Imbrium impact. The Apennines are an arcuate chain of highlands that display chaotic dunelike topography in the south and massif/domical terrain in the north near the landing site. Extensive slump blocks along the basin-facing (northwest) scarp occur along the Apennines, as do bright, fresh talus slopes around most of the massifs.

There are few large blocks on most of the massif slopes, but streaks of low-albedo material are evident on high-sun angle panoramic photographs.

The highlands were sampled on the Hadley Delta massif, a mountain block about 15 x 20 km, rising above 3400 m above the mare plain. Its relief exceeds the ~1 km estimated thickness of Imbrium ejecta [Cart and El-Baz, 1971]. The possibility of exposure of a pre-Imbrian section within Hadley Delta enhances the importance of contributions to the Apollo 15 highland samples from pre-Imbrian basins, particularly Serenitatis. Premission geologic analyses suggested that most of the highland samples collected on Apollo 15 would be breccias.

Although sampling of the Apennine Front was the prime target of the Apollo 15 mission, the front's petrology remains one of the major outstanding problems. The sampled talus deposit is dominated by mare debris and mare-rich breccias, and highland material is sparse and generally cryptic. The abundant regolith breccias from the front contain mare basalt, green and other volcanic glasses, KREEP basalts, and basaltic mineral debris and obviously were formed after the Imbrian impact. They do contain small lithic and mineral class of highland derivation, but their are not yet been examined in detail.

"Genesis rock" 15415 received the earliest attention even during the mission; it is an anorthosite (i.e., consists almost entirely of plagioclase) from the rim of Spur Crater. It has had a complex history of metamorphism and shock, and isotopic data suggest that it is a remnant of the earliest lunar crust, despite its 40Ar-39Ar age of only about 4.1 b.y. It does not represent a common component of the Apennine Front, however, although a few similar samples and smaller fragments exist in the Spur Crater rake samples. Other less plagioclase-rich, phoncite-igneous rock fragments are present, for example, as clasts in the "black-and-white" rocks 15445 and 15455. They include anorthositic norite, norite, and spinel (peridotite)-bearing troctolite. An anorthositic norite (shown in Figure 5a)
melts; further analytical work should clarify the number and perhaps the sources of the melt sheets.

Where sampled, the Apennine Front is contaminated with green volcanic glass, mare debris, and KREEP basalts. Two sets of data suggest that a low-K Fra Mauro composition similar to that of the impact melts is the average of the front proper: glass compositions and regolith chemistry mixing models. Several early microprobe studies [e.g., Reid et al., 1972; Carr and Meyer, 1973] of the compositions of glass fragments in regoliths found that the low-K Fra Mauro composition was common, formed a dome and increased in abundance toward the front. Subsequent studies of the chemistry of the regolith at both mare and front sites showed the necessity of such a component [e.g., Duncan et al., 1975]. However, these studies have not yet been directed to defining the average composition of the front. In any case, it is reasonably well established that the Apennine Front is not anorthositic or even as aluminous as the Apollo 16 highlands site but rather is basaltic or noritic. This is consistent with orbital geochemical data for the Apennines [Clark and Hawke, 1981]. The low-K Fra Mauro composition cannot be formed as a mix of the igneous lithologies found either at the Apollo 15 site or any other landing sites, and its petrogenesis remains somewhat of a mystery.

Apollo 15 samples completely lack the heterogeneous polymict fragmental breccias that dominate the Apollo 16 samples. The Apollo 15 highlands are more subdued and have a thicker regolith than the Apollo 17 massifs (in a similar geological situation but having steeper slopes and “recent” landslides). It is very likely that the Front consists dominantly of friable material, including polymict fragmental breccias, of which the sampling locations has disaggregated to fine-grained debris. It is unlikely to consist dominantly of impact melt so far from the basin center. Obviously, to characterize the Apennine Front properly, we must scrutinize those small samples and particles that received scant attention, perhaps because of time constraints, near the time of the mission. Until the terrain components are identified, the events and processes that formed them cannot be deciphered, and the Imbrium Basin and its ejecta cannot be properly understood.

**Apollo 15 KREEP Basalts**

KREEP basalt fragments are ubiquitous at the site, although rather small; only two are individually numbered. Apollo 15 KREEP basalts are the largest mass of only 7.5 g. This characteristic means that geologic observations unfortunately can play a little part in deciphering them. Their age is indistinguishable from that of the Imbrium impact, but there is orbital chemical and geologic evidence that they form the Apennine Bench Formation (see cover; also Spudis, 1978; Hawke and Head, 1978) and hence postdate Imbrium. However, zircons in the quartz-monozonidiorite (“Super-KREEP”) clasts in 15405, which appear to be related to the KREEP basalts by crystallization [Ryder, 1976], have yielded Pb-isotopic ages of 4.35 b.y. [Compton et al., 1984], leaving a dilemma as to their origin, history, and relation to the KREEP basalts.
The site distribution of Apollo 15 KREEP basalt has suggested to some workers that most fragments were delivered to the landing site by rays from the craters Aristillus or Autolycus to the northwest. However, the Apennine Bench Formation is visible much closer to the landing site (cover), and it is probable that the KREEP basalts underlie the mare basalts at or close to the landing site itself. The lunar module (LM) site lies on a low (~5 m), broad ridge that was originally considered to be ray material [Apollo Lunar Geology Investigation Team (ALIGIT), 1972]. Alternatively, the ridge could be a premare topographic feature consisting of KREEP basalts (Apollo 15 KREEP basalts compose about 30% of LM area soils). The presence in sample 15205 of KREEP basalts and glasses derived from them, with pyroxene-phryric mare basalts, green glasses, and some other mare glasses, to the exclusion of any recognizable terra component [Dymek et al., 1974] is consistent with the existence of a terrain of post-Imbrium KREEP basalts underlying the mare. The flows succeeded the Imbrium impact so closely that the impact may have caused their emplacement. The geologic relations would be consistent with the KREEP basalt as Imbrium impact melt [e.g., Taylor, 1982] as it did not for other characteristics of the basalts and its being too "hot" to form much of the crust (it would have led to very high heat flow values) in pre-Imbrian times [Ryder and Wood, 1977; Spudis, 1978]. The composition of KREEP basalts suggests the presence of a plagioclase-bearing crustal source region, much shallower than that of mare basalts, established more than 4.3 b.y. ago. The elucidation of their origin is essential to understanding both the development of KREEP on the moon and their distribution as small fragments around the site.

Mare Volcanism

The landing site lies on the mare of Palus Putredinis, isolated from the general flows of Mare Imbrium by the Apennine Bench to the west and south and Archimedes crater to the northwest [Carr and El-Baz, 1971]. Palus Putredinis is divided by earth-based remote-sensing studies into two units [Whitford-Stark and Head, 1980]. Most of this mare patch consists of late Imbrian-early Eratosthenian basalts, with a regolith with 1.5–3.0 wt% TiO₂ developed. The Apollo 15 site itself is situated on a patch of spectrally distinct mare basalts regolith (TiO₂ < 1.5 wt% of similar age (although collected samples of mare regolith actually contain 1.5–2.0% TiO₂). Basalts surrounding Palus Putredinis consist of two units. One is a late Imbrian-age, moderately blue unit (TiO₂ 1.5–3.0 wt%) north of the site; the Copernican age craters Aristillus and Autolycus formed on this unit and may have deposited some of its material (as yet, unrecognized) at the Apollo 15 site. A younger, Eratosthenian age series of flows occurs northwest of Archimedes; these flows are very blue (TiO₂ > 3.0 wt%) and appear to be the distal ends of the young blue basalt flows described by Schaber [1973]. Both the very red southern rim of Archimedes [Whitaker, 1972] and several dark deposits within the region [Hawke et al., 1979] suggest that glassy pyroclastic deposits discontinuously cover both highlands and mare in the vicinity of the site.

The mare plains were sampled at six separate traverse stations (Figure 2), and a few mare basalts turned up among the front samples. Mare basalts belong dominantly to two distinct types: quartz-normative (pyroxene-phryic) and olivine-normative basalts. Among large samples, they are about equally abundant. Olivine-normative basalts dominate the rille samples (most less than 25 g in mass) from station 9A, about 20 m from the rille edge, but are also present as the one isolated basalt sample from station 3. Some specimens were collected at stations 2 and 7 on the front, and an impact-melted example was collected at station 6 on the front. Olivine basalts range from fine to medium-grained (grain size less than 2 mm), and many are spectacularly vesicular (Figure 5b). Pyroxene-phryric basalts were collected at stations 1 and 7 (where only a few samples were collected altogether), at the LM site, and at the rille edge, although only a few are representative of the station 9A rille sample. They are absent from the Apennine Front except at Station 2, where several small examples occur in the rille samples and are the dominant mare component in the boulder from which 15205 was collected. Pyroxene-phryric basalts range from glassy to phenocrystic varieties, with pigeonitic crystals up to several centimeters long. Three small olivine-rich basalts in the Spur Crater rille samples appear to be petrographically distinct from the olivine-normative group, but data on them are too sparse to claim them as derivatives of distinct magma types. The mare basalt groups have indistinguishable ages (3.3 b.y.), initial Sr isotopic ratios, and rare earth element patterns (Figure 4) yet cannot be related by melting or fractional crystallization. Some authors have proposed, on the basis of subtle trace element variations, that each group of basalts comprises subgroups, but confirmation awaits more critical analyses of representative samples of selected basalts.

The excavation depth of mare basalts from Elbow Crater (station 1) was probably of the order of 35–40 m [Crockett, 1980]. Dune Crater (station 4) is part of the South Cluster, a secondary impact crater complex produced during the Aristillus/Autolycus impacts [Howard, 1971] and hence is not expected to excavate as deeply as would a primary impact crater [Schultz and Gault, 1985]. A reasonable estimate for its sampling depth suggests a basalt thickness of at least 10–20 m in this area. At station 9A on the lip of Hadley Rille, both mare units were sampled: an upper unit of olivine basalt on the rim of the rille and a lower unit, 1–2 m below the rille rim, exposed as bedrock of pyroxene-phryic basalt. The sampled units may correlate with layers in the walls of the rille (Figure 3). That olivine basalts are found in quantity in the rille sample at station 9A (rille rim) has suggested to some authors [e.g., ALIGIT, 1972; Logfren et al., 1975] that a thin (~2 m) flow of olivine basalt overlies thicker flows of pyroxene basalt; thus the olivine basalts would appear to be a minor component at the site. One prob-
lem with this interpretation is that large quantities of olivine basalt are required to perform mixing models of Apollo 15 soils [Duncan et al., 1975]. This problem may be an artifact of the improper selection of the highlands end member (e.g., it may be too low in Mg); use of more magnesium terra components (e.g., 13445 black matrix) as highland end members may be more appropriate.

The olivine-normative basalt group has a chemical variation consistent with fractional crystallization of olivine, but the pyroxene-phric group shows very little variation, even though cooling rate estimates, made on the basis of dynamic crystallization experiments, suggest flow thicknesses up to 20 m [e.g., Grove and Walker, 1977]. The source vents for the basalts are unknown, and their relation to Hadley Rille, whose source is over 50 km to the southwest, is not established. It seems clear that considerable crystallization must have taken place as the lavas flooded the lunar surface (especially as some younger Imbrium mare lava flows appear to have travelled as far as 1000 km; see Schaber [1973]). Such flow lengths also create the opportunity for assimilation, and the formation of Hadley Rille might have included assimilation if it incorporated downcutting. Terrestrial komatiites appear to have been capable of assimilating the terrain over which they flowed. On the other hand, if the flows travelled any great distance, one might not expect volatiles to remain in sufficient abundance to have created the 30–40% vesicularity of many of the olivine-normative mare basalts. Relations between the basalt chemistry, fractionation, assimilation, flow thicknesses, site stratigraphy, and Hadley Rille have not yet been fully explored.

Hadley Rille was studied at three stations (2, 9A, and 10) at the Apollo 15 site [Howard et al., 1972], where it is about 300 m deep and 1500 m wide; enormous by terrestrial standards. The rim at station 9A is 30–40 m higher than its corresponding far side. One of the most spectacular discoveries was layered bedrock outcrops within the upper 60 m of the far rille wall (Figure 3). The lowermost unit is layered and about 8 m thick; the overlying 5-m interval is covered and in turn overlain by a massive, poorly jointed unit about 17 m thick. Above the massive unit is a thin (1–2 m), dark unit on which regolith is developed [Howard et al., 1972]. These exposures give direct evidence for at least a 30–40-m thickness of basin.

The observations of Hadley Rille are consistent with the lava tube/channel hypothesis, and any debate is about the precise mechanism. In the Greeley [1971] model, sinuous rilles form by single, prolonged eruptions, with the lava flow gradually becoming confined within a tube by cooling of the distal margins. This model implies a total mare thickness of at least 300 m, the present depth of the rille. Alternatively, Carr [1974] investigated the role of lava erosion by rille formation and concluded that Hadley Rille probably formed by the erosion of flabby, brecciated terra basalt. The exposed outcrops of basalt in the rille walls could then represent the total mare thickness. These basalts would thus rest unconformably on the Imbrium Basin floor deposits or KREEP basalt flows.

On extravalvicular activity (EVA) 2, Scott noted a dark, elongate basin along the base of Mount Hadley, possible evidence that the lavas in the vicinity of the site were ponded and subsequently subsided to a level ~ 80–90 m lower [Swann et al., 1972; Howard et al., 1972]. In this case the rille may have served to drain some of these ponded lavas. The presence of mare samples at Spur Crater (about 50 m above the mare level) is perhaps consistent with this hypothesis.

**Volcanic Glasses and the Mantle**

Mare basalt lavas are fractionated, certainly during flow if not during ascent, and hence are severely limited as sources of information about the lunar mantle. Furthermore, their chemistry may have been affected by assimilation. However, volcanic "pyroclastic" glasses are more magmatic, are erupted more rapidly, and are more probably samples of magmas as erupted. They appear to have been little fractionated during ascent and represent our most reliable probes of the lunar mantle. At the Apollo 15 landing site, volcanic green glass, which is a very low-Ti, high-Mg glass, is common. It forms clods, which were sampled at station 7 and occur in the core at station 2, and its distinctly green color was observed on the front by the astronauts; for instance, the boulder at station 6A (15405) was covered by green soil. Detailed analyses of the green glasses [Delano, 1979] showed that there are five distinct compositional groups. The glasses are more primitive than more lavas in several respects. High-pressure phase experiments suggest a depth of origin of about 400 km, from an olivine plus low-Ca pyroxene source that is one of the most magnesian so far inferred. Nonetheless, this source is not primitive but is differentiated, as green glasses have a small negative europium anomaly (Figure 4). At present it is not clear how the five groups relate to each other, nor whether they were erupted sequentially or simultaneously. Whether a single near-pure clod of glass contains more than one group has not been established; the relevant analyses have not yet been made.

Two other volcanic glasses have also been identified: one yellow, with an intermediate TiO₂ content, which is 3.6 b.v. old, and one red, with a high TiO₂ content, which is undated. These glasses also appear to have come from great depths and from differentiated sources but indicate a greater complexity of source formation, possibly requiring mantle-level assimilation of sinking ilmenite-rich cumulates.

A yellow impact glass similar to but not identical with the yellow volcanic glass in major element chemistry but much higher in rare earths (KREEP pattern) has an age indistinguishable from that of the green glass and...
local lavas. The target source of this glass remains unknown, and its possible identification awaits data from a lunar geochemical polar orbiter. There is a lack of data for trace elements, ages, radiogenic isotope ratios, and stratigraphic context, which at present limit an understanding of the relations between glass groups and other geologic units. The green glasses also have primitive volatiles on their surface and volatiles trapped within them that have the potential to inform us about a little-understood component in the lunar interior, a component that is significant for both the moon’s origin and its evolution. A wide variety of mantle-derived materials is present on the moon. Their synthesis can provide useful guides to the composition, variation, and origin of the mantle at a single spot.

Regolith and Postmare Cratering

The conjunction of the older steep highlands and younger flat mare make the Apollo 15 site particularly appropriate for examining postmare regolith development, the roles of lateral and vertical mixing, and talus development. A thick regolith on at least the lower part of the front thins to a depth of about 3 m on the mare and to almost nothing at the rille edge. Clear chemical differences exist among regoliths from different stations, while at a given station the regolith samples are similar. Regolith breccias are also mainly locally derived, mimicking local soil chemistry; an exception is that several breccias are richer in Apollo 15 KREEP basalt than are local soils. Fragments of mare material on the front probably represent lateral mixing, but the highlands component in mare soils could be derived from either vertical or lateral mixing. Its decrease away from the front suggests that lateral mixing is dominant but at a scale of only a few kilometers.

Rays from Aristillus, Autolycus, or both have been identified on orbital photographs, but as yet there are no criteria to identify specific ray-derived materials among samples. It was commonly believed in early analyses that the KREEP basalts were brought in by such rays, but more local sources are available.

Boulders 15405 and 15205 were thrown in after mare emplacement, but 15205 at least did not come as far from or arrive as long ago as Aristillus or Autolycus. One problem is that the target materials at Aristillus and Autolycus do not seem to be very different from materials near the landing site, although the mare lavas in that area are different and might be expected to be identifiable. The South Crater is a set of secondary craters produced by the Aristillus or Autolycus events, and a set of small secondaries aligned up the front was observed by the Apollo 15 crew. Thus the Apollo 15 site is an appropriate location on the moon for the study of the effects of ray deposition and secondary cratering.

Conclusions and Workshop

The Apollo 15 landing site encompasses a remarkably complete basin stratigraphic section. Aspects of the larger lunar processes—basin-scale impacts, secondary cratering, and regolith development, crustal volcanic and plutonic activity, and mantle melting and origin—can be profitably studied from the samples and observations at this single location. Data from the site are especially significant in conjunction with orbital data that allow extrapolations farther afield and with input from our understanding of other landing sites and from continuing meteoritical and terrestrial studies. The Apollo 15 site could one day become a lunar base. Although the mission was in some respects “forgotten,” the immanent appearance of a catalog of Apollo 15 rocks (from the Planetary Materials Branch, Johnson Space Center, Houston, Tex.), and the near-completion of the Apollo 15 field geology report (U.S. Geological Survey, Flagstaff, Ariz.) provide a substantial opportunity for proper reappraisal and synthesis of our understanding of the site and for evaluation of gaps in our knowledge and avenues of future research. An important part of this process will be the Workshop on the Geology and Petrology of the Apollo 15 Landing Site, sponsored by the Lunar and Planetary Institute. This will be held Novem-

ber 13–15, 1985, to review our current understanding of and future research possibilities on the landing site. The workshop will be at the Lunar and Planetary Institute in Houston, Tex. Authors P. D. Spudis and G. Ryder are the convenors. For details, contact Pam Jones, Lunar and Planetary Institute, 5303 NASA Road 1, Houston, TX 77058.

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