In summary, the lack of reliable as well as precise isotope data for Apollo 17 igneous rocks inhibits our ability to make confident statements regarding their ages and origins. However, the present state of isotopic art is progressing in the right direction, such that we should be able to obtain more precise data in the coming years, even with the present set of lunar samples. Nonetheless, its obvious that we need larger, pristine, monomict highland samples if we are to finally arrive at real answers.

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THE APOLLO 17 SAMPLES: THE MASSIFS AND LANDSLIDE. Graham Ryder, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston TX 77058-1113, USA.

More than 50 kg of rock and regolith samples, a little less than half the total Apollo 17 sample mass, was collected from the highland stations at Taurus-Littrow. Twice as much material was collected from the North Massif as from the South Massif and its landslide. (The apparent disproportionate collecting at the mare sites is mainly a reflection of the large size of a few individual basalt samples.) Descriptions of the collection, documentation, and nature of the samples are given in [1–3]. A comprehensive catalog is currently being produced (Ryder, in preparation). Many of the samples have been intensely studied over the last 20 years and some of the rocks have become very familiar and depicted in popular works, particularly the dunite clast (72415), the troctolite sample (76535), and the station 6 boulder samples. Most of the boulder samples have been studied in Consortium mode, and many of the rake samples have received a basic petrological/geochemical characterization.

Sample Numbering: Samples from the South Massif are numbered 72xxx (station 2, but the 721xx samples are from LRV stops on the mare plains), 731xx (station 2 and 2a/LRV-4), and 732xx (station 3, on the landslide). Samples from the North Massif are numbered 76xxx, 77xxx, and 78xxx, with the second digit specifying the station, with the exception of a few LRV stop samples. Rock samples have numbers whose last digit is from 5 to 9; unsieved regolith (including cores) have last digits of 0, and sieved fractions end in 1 to 4 according to the size fraction.

Rock Sampling: Sampling of rocks at the Taurus-Littrow massifs was very comprehensive in style. Multiple rock samples were chipped from boulders of varied sizes ranging from less than a meter to the bus-sized station 6 boulder. The multiple samples were taken to evaluate the visible textural and possible chemical variations of the matrices of the boulders necessary to elucidate their origins, as well as to sample clasts that give insight to older lunar events. The station 7 boulder not only had different matrix textures visible during the field study, but also dikelets that cross-cut an extremely large clast as well. Different subsamples of boulders also had different exposure geometries, providing greater input to cosmic and solar radiation models. Individual documented (i.e., photographed *in situ*) and undocumented rock samples, not obviously directly related to boulders, were also collected. At several stations, samples were collected by raking with a 1-cm-separation rake. Two rake samples were taken at station 2, one at the base of the massif, a few meters from boulder 2, the other on the landslide 50 m away from the base. No rake sample was collected further out on the landslide. On the North Massif, rake samples were taken on the ejecta of a small crater at station 6, and on the rim of a small crater at station 8.

Regolith Sampling: Regolith samples were taken at all massif stations. Samples were taken of general regolith and of material on, under, and adjacent to boulders, mainly by scooping and some by trenching. A double drive tube (total about 70 cm depth) was collected on the light mantle at station 3, and a single drive tube on the North Massif at station 6, to a depth of about 37 cm.

Rock Types: The rock samples collected are different in character as a population from those collected on the Apollo 16 mission or from the Apennine Front on the Apollo 15 mission. In particular, all the larger boulders except boulder 1 at station 2 are very similar in chemistry and crystalline nature to each other, and to a very large proportion of the individual rock and rake samples collected. They have an aluminous basaltic composition with a KREEP incompatible element signature, falling in the general group of low-K Fra Mauro basalts (LKFM) originally defined for samples from the Apollo 14 site. They have crystalline melt matrices ranging from fine grained with olivine microphenocrysts (e.g., 76035) to poikilitic or ophitic (e.g., station 6 boulder). All of them contain mineral and lithic clasts (the latter mainly feldspathic granulites and pristine igneous fragments such as the dunite) and have meteoritic siderophile contamination, with the general similarity of Ir/Au about 1.5 (see summary in [4]). Radiogenic isotope data suggest a common age of around 3.87 Ga for the melting of these samples. The consensus is that these samples represent the impact melt produced by the Serenitatis Basin event. They dominate the sample collection in part because boulders were sampled in accordance with the field plans, and boulders tend to be from the coherent part of the Serenitatis rubble pile, which is the impact melt; older coherent units were broken up by the Serenitatis event.

Boulder 2 at station 2 is different in that it has a friable matrix consisting of a crushed volcanic KREEP basalt and aphanitic melt. This is texturally perhaps (but not chemically) the closest thing to the fragmental breccias at the Apollo 16 site. However, the bulk of boulder 1 consists of aphanitic melt alone, and these melts are different in chemistry from the "Serenitatis" melts, particularly in that they have much lower TiO_2. Some individual rocks collected on the light mantle are very similar to the boulder 1 aphanites, and one of them is a melt "bomb" [5]. As a group they have a clast population different from that of the "Serenitatis" melt (as well as a greater clast content); in particular, they contain more conspicuous granitic (or felsitic) fragments. If these aphanites do not represent an impact distinct from Serenitatis, then they must represent a substantially different phase of it than do the poikilitic rocks (see [4,6] for discussions). The radiogenic age of the aphanitic melts is indistinguishable from that of the poikilitic rocks.

Other impact melts of different composition are present in the Apollo 17 collection, but the range is not as great as that observed among Apollo 16 samples; extremely aluminous melts appear to be absent.

Feldspathic granulites (metamorphosed polymict breccias, most with more than 25% Al_2O_3) are fairly common as small clasts, but a few are individual rake or rock fragments as well. Far greater attention has been given to the pristine plutonic igneous rock fragments that occur both as clasts in the impact melt rocks and as individual fragments (which may once have been clasts in melt units). Most are in the Serenitatis melts, e.g., the dunite 72415, the large norite 77215 (from a meter-sized clast within the melt), and the gabbro in the station 6 boulder. Others occur as smaller clasts within the aphanitic melts, e.g., the norite clast and the granitic fragments in boulder 1, station 2. Among the individual rocks are the troctolites 76335 and 76535, and the samples of shocked and melted norites (78235) that represent a single meter-sized boulder. These pristine igneous rock fragments have produced radiogenic ages mainly in the range of 4.0 to 4.3 Ga, but some may date back to as much as 4.5 Ga. Conspicuously absent (or perhaps just extremely rare) are the ferroan anorthosites common at the Apollo 16 site and present at the Apollo 15 site.

Regolith breccias are uncommon among the massif samples, although some, including glassy breccias, do occur. The sampling bias toward coherent and boulder samples, and the steep slopes working against the production of lithified regolith, may be responsible for this lack. Furthermore, the South Massif landslide would have diluted the uppermost regolith (the source of regolith breccias) with fresher bedrocks, at least at that one location. Mare basalts are rare among the massif samples, even the rake samples, certainly not surprising in view of the downslope movement, including the landslide, at most of sampling sites. The regolith particles tend to reflect the larger rock types, with feldspathic granulites, poikilitic impact melts, and plutonic fragments recognizable. There is little dilution with mare components, and orange glasses are rare. The regolith samples from the North Massif are contaminated with mare basalt or volcanic glass (TiO_2 3% or 4%), but the purest regoliths from the South Massif have little mare contamination. They are only a little more aluminous than the average LKFM "Serenitatis" melt. However, they have only half the abundance of incompatible elements, demonstrating that the soil contains a much lower proportion of the "Serenitatis" or aphanitic melt than might be expected from the relative abundance among the larger rock, rake, and boulder samples. The component underrepresented in the rocks is not particularly anorthositic, but must be low in incompatible elements.

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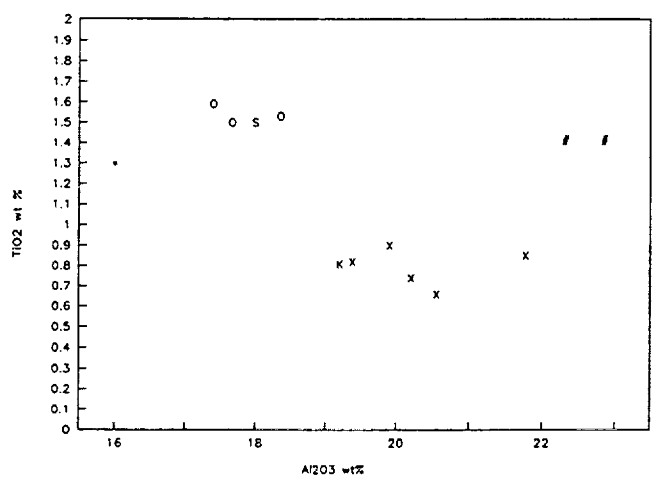
N93-18810 p. 2

IMPACT MELT BRECCIAS AT THE APOLLO 17 LANDING SITE. Graham Ryder, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston TX 77058-1113, USA.

Impact melt breccias are by far the most common highland rock type collected on the Apollo 17 mission. They tend to be fine grained, with virtually no clast-free impact melt rocks having been identified. All the highland boulders sampled are impact melt breccia, with the possible exception of one South Massif boulder that might have a friable matrix (but nonetheless consists dominantly of impact melt) and a shocked igneous norite boulder from the North Massif. The impact melt breccias were originally described as metaclastic, but their melt origin became apparent as work progressed [1,2]. Chemical compositions appear to allow natural groupings of the impact melt breccias. The present abstract relies in part on some new chemical analyses performed by the author (Fig. 1).

Most of the impact melt breccias are assignable to a single chemical group that is commonly accepted as being produced by the Serenitatis Basin event [1–3]. Most of these samples have crystalline groundmasses with fine- to medium-grained poikilitic matrixes. They dominate the rake samples and the boulders. Most of the remaining impact melt breccias are similar in chemistry to the dominant crystalline melts, but have distinctly higher Al_2O_3 and much lower TiO_2 [4–6]. Their compositions are not as uniform as the "Serenitatis" melts, and have some differences both within and among samples. They are also distinct in having aphanitic melt groundmasses and a greater abundance and diversity of lithic and mineral clasts. These aphanitic melts have been found only among samples from the South Massif.

Three other melt compositions are represented only by single samples: (1) 76055, more magnesian than the "Serenitatis" melts, and with lower incompatible element abundances [7,8]; (2) 72735, a high-K impact melt [9,10]; (3) a poikilitic clast in aphanitic melt 72255, similar to the "Serenitatis" melts but with higher alumina and lower incompatible element abundances [11].



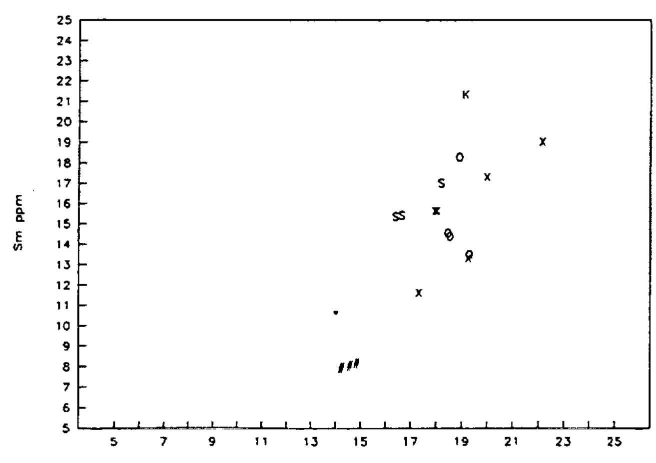


Fig. 1. Chemical analyses (TiO_2 v. Al_2O_3; Sm v. Sc) of impact melt rocks acquired in 1992 by the author, using INAA and fused beads (except 76055 = *, data of [8]). O = "Serenitatis" melt rocks, previously analysed. S = Serenitatis melt rocks, previouslyt analyzed but reanalyzed by INAA. X = 72255 aphanitic melt phase. # = 72255 poikilitic clast. K = 72735 high-K melt rock.