Introduction to Large Boulder at Station 6
Samples 76015, 76215, 76235, 76255, 76275, 76295, and 76315

Also samples 76245, 246, 265, 285, and 286 may have been spalled off the boulder at Station 6. Samples 76230, 236, 237, 238, 239, 305, 306, and 307 are all part of 76235, which was chipped from a distinct clast on Boulder 6.

GEOLOGICAL SETTING

Most of the large samples collected at the Apollo 17 Station 6 are from a large broken boulder (6 x 10 x 18 m) lying at the end of a boulder track that can clearly be seen in the photos taken by the astronauts (see Schmitt and Cernan, 1973, and Wolfe and others, 1981). This boulder track leads from a distinct blocky horizon approximately 1/3 of the way up the North Massif. On the basis of observation of several boulder tracks on North Massif, it appeared to the astronauts that once a boulder was jarred loose from its "source-crop" and began to roll, only a decrease in slope or the break-up of the boulder would stop it. At the end of its track, the big Station 6 Boulder apparently broke into five distinct blocks (Fig. 1) and came to rest at the top of the talus from the North Massif. Blocks 1, 2, and 3 readily fit together; the fit of Boulders 4 and 5 is less obvious. According to Arvidson et al. (1975), the emplacement of the Station 6 Boulder is one of only a few well-dated events on the Moon (22 m.y.).

The Station 6 Boulder is the closest thing to a geological outcrop on the Moon! Photos of the boulder blocks were mapped by G. Heiken et al. (1973) in preparation for the consortium study of the samples led by W. Phinney, C. Simonds, and J. Warner (Figs. 2-6). The Station 6 Boulder was found to be a geologically complex, clast-bearing, impact melt breccia with a matrix that is chemically rather uniform. Four main lithologic units within the boulder cluster have been identified (Heiken et al., 1973, and Phinney, 1981). Unit A is characterized by abundant vesicles (some greater than 5 cm long) flattened along a plane parallel to the contact with the adjacent unit (no samples taken). Unit B is characterized by well-developed foliation or banding (samples 76015 and 76215). Unit C is massive, with no obvious foliation, and contains angular clasts up to 0.8 in long (samples 76235, 255, 275, 295). Unit AB is a discontinuous transition zone up to a few meters wide between units A and B (sample 76315). The samples (described individually) are impact melts and anorthositic clasts. The matrices of the Station 6 Boulder samples contain 50-60% calcic feldspar, ~45% orthopyroxene, and 1-7% ilmenite.

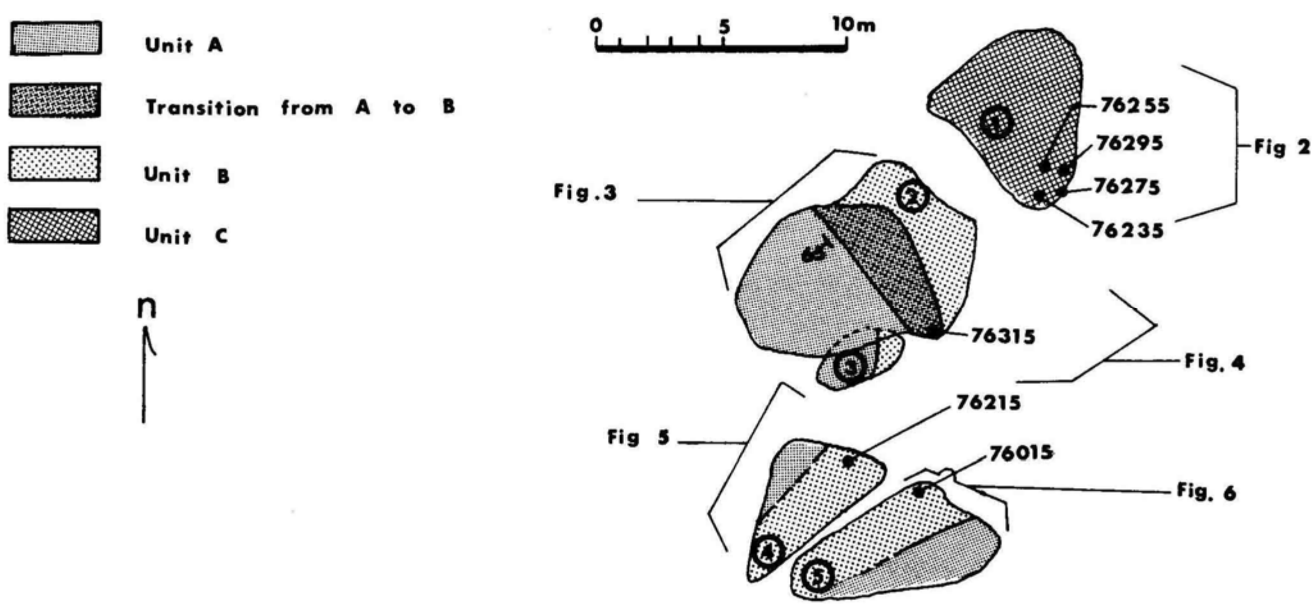

Figure 1: Map of the boulder cluster at Station 6, showing sample locations, location of lithologic units, and index to boulder maps. From Phinney (1981).

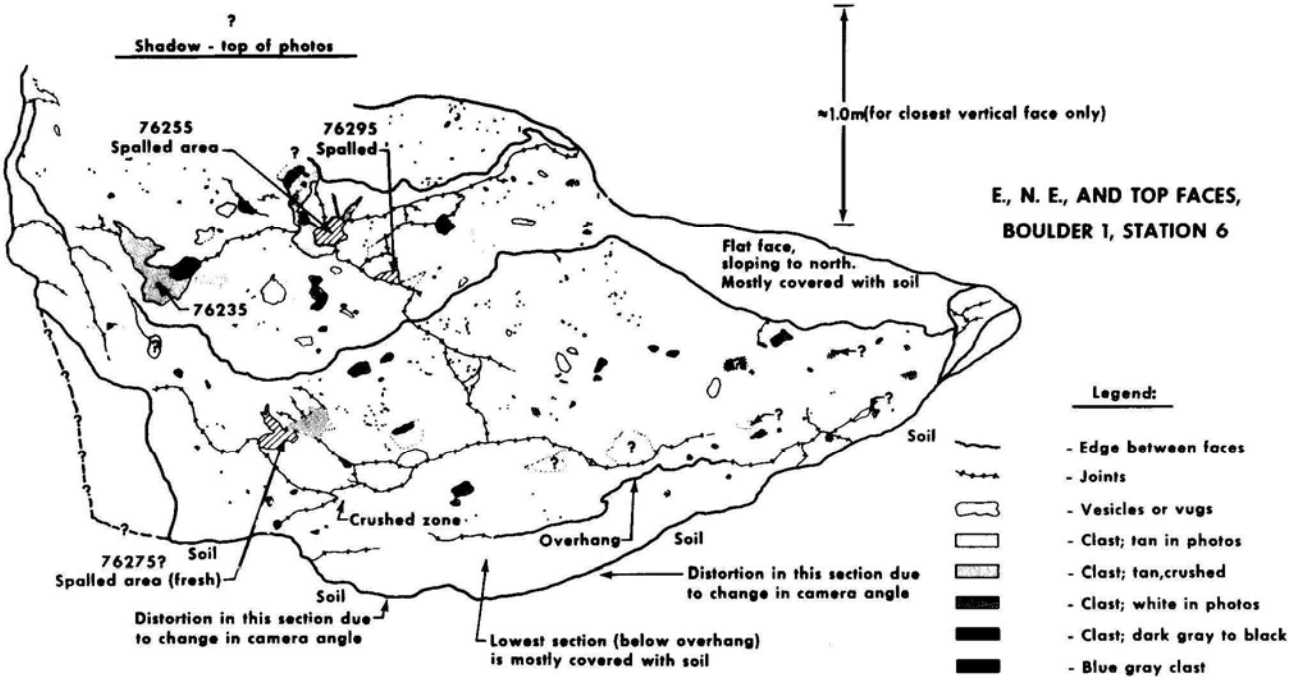

Figure 2: Map of the east, northeast, and top faces of Boulder1. From Heiken et al. (1973).

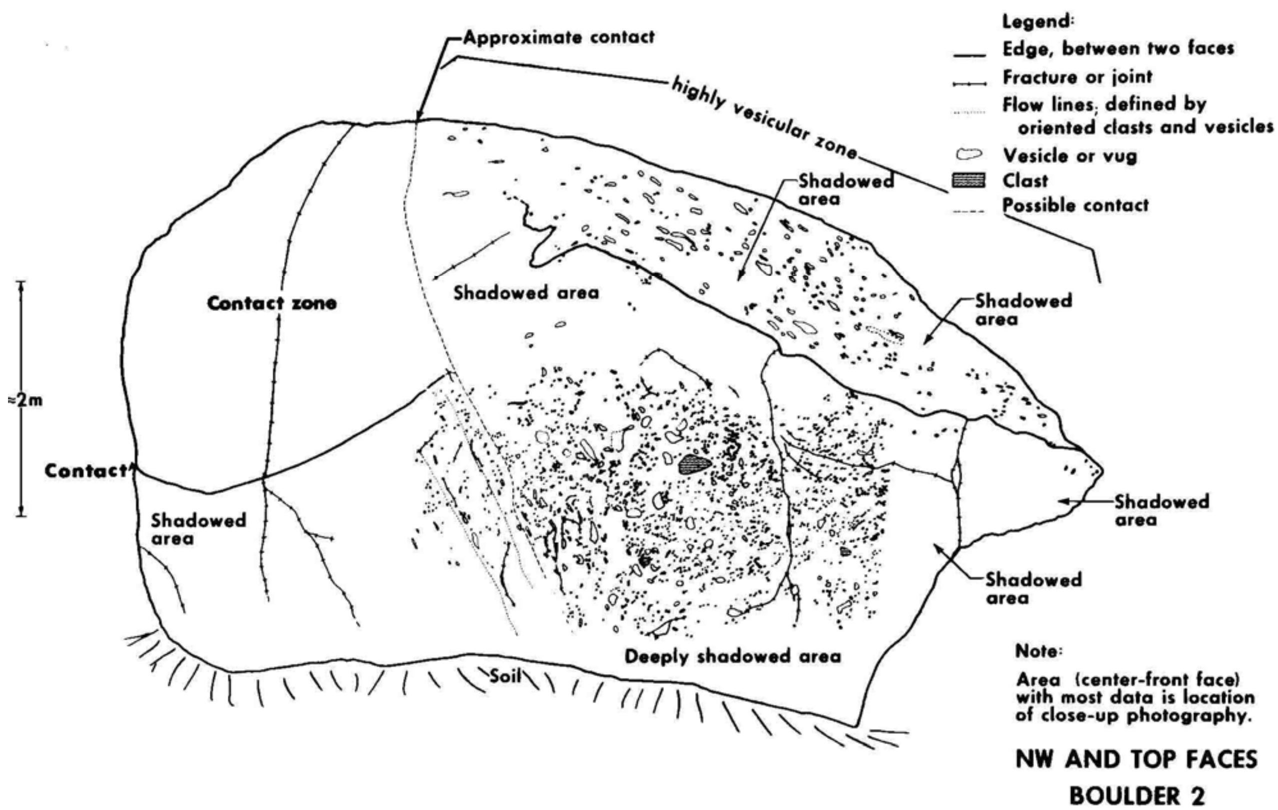

Figure 3: Map of the northwest and top faces of Boulder 2. From Heiken et al. (1973).

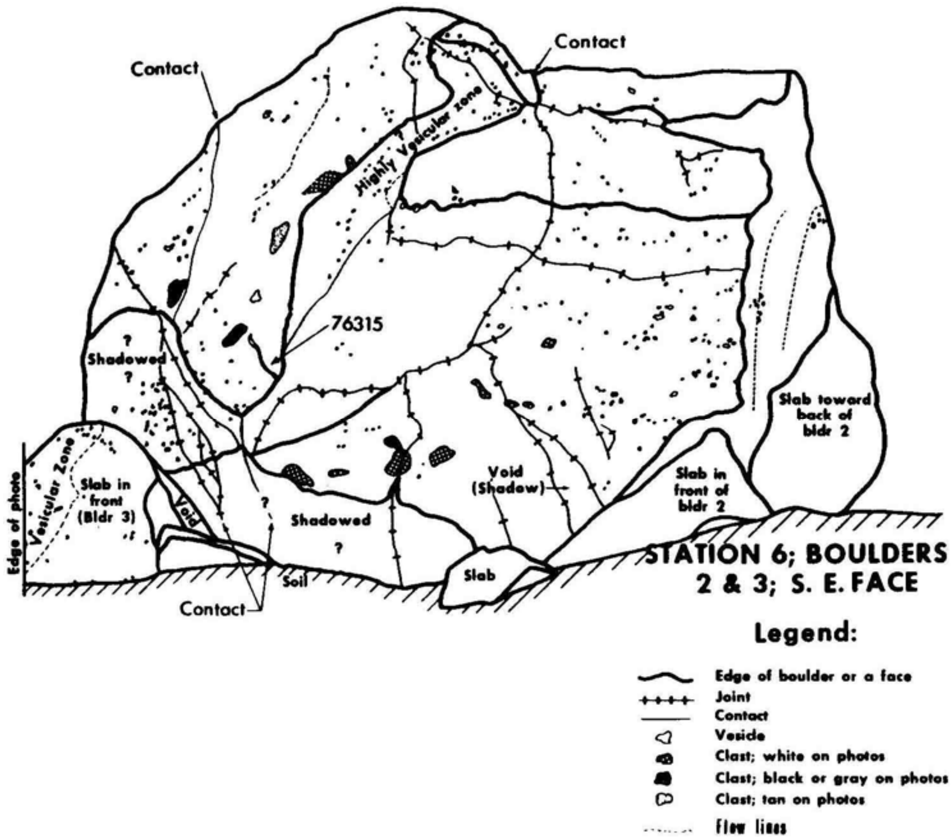

Figure 4: Map of the southeast face of Boulders 2 and 3. From Heiken et al. (1973).

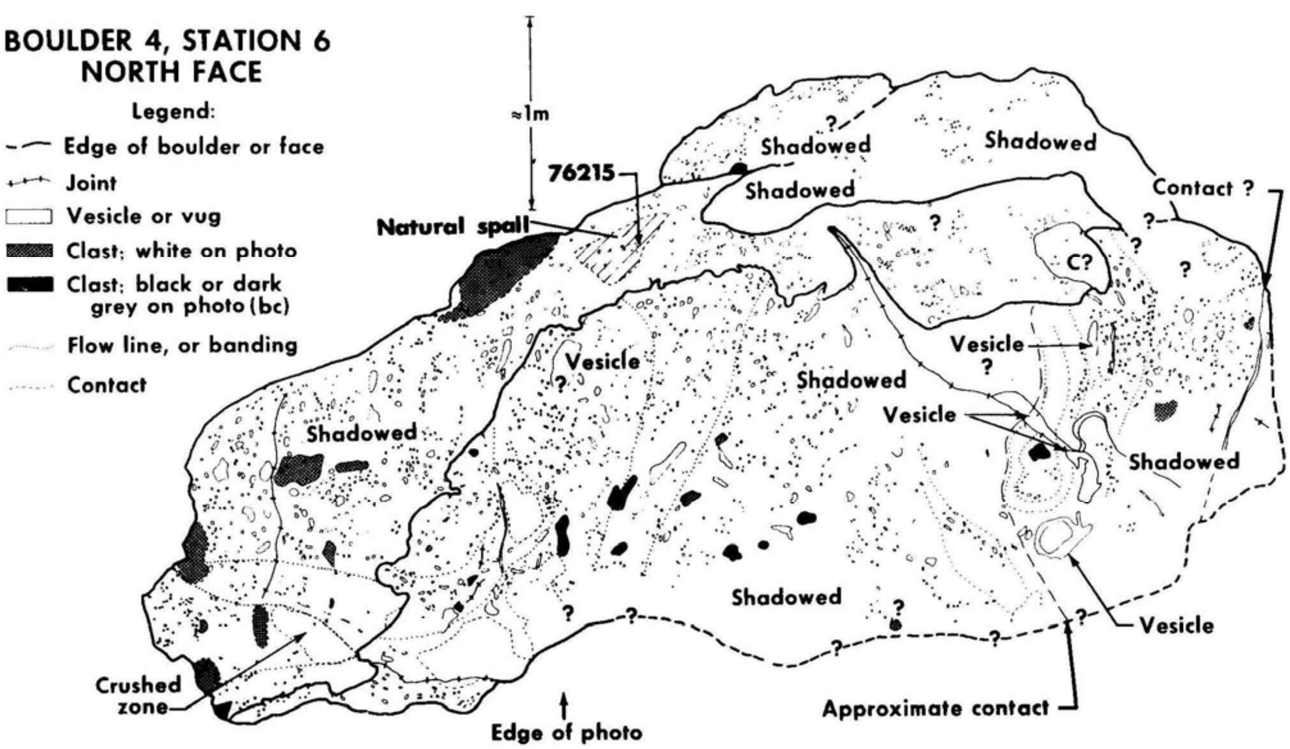

Figure 5: Map of the north face of Boulder 4. From Heiken et al. (1973).

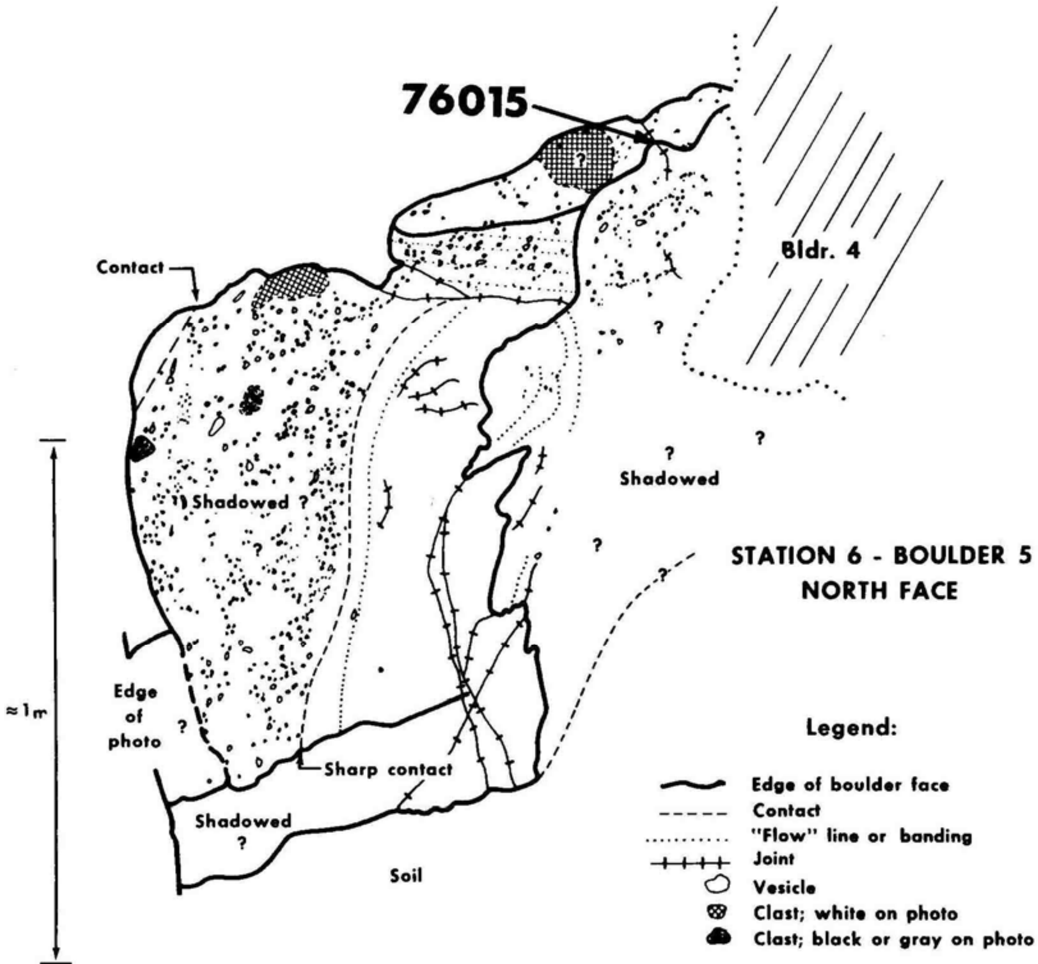

Figure 6: Map of the north face of Boulder S. From Heiken et al. (1973).

important clasts contain -70% feldspar, 30% orthopyroxene, and olivine and trace ilmenite. The matrix of the boulder was apparently homogenized extremely well by the impact process on the scale of this boulder. The major and trace element compositions of the various pieces of matrix form a tight cluster on composition diagrams, including the siderophile elements (Ir-Au-Re) contributed by the meteorite projectile. The clasts display various degrees of brecciation and shock metamorphism. Some clasts (76235, 76255) may be of plutonic origin.

The boulders at Station 6 do not have a composition like that of the soil (Fig. 7). Station 6 is located on the talus of the North Massif. Components of the soil include the boulders, the adjacent mare surface, and the softer portions of the North Massif. It will take a careful study of the coarse fines from the soil to discern what the rest of the North Massif is made of (Jolliff et al., 1993). Samples like 76535 and 76335 may be more representative of the main portion of the North Massif than the samples of the boulder.

PATINA

A distinct brown patina is well developed on all the weathered rock surfaces of the otherwise tan or blue-grey breccia, including the fractured surfaces of the blocks of the Station 6 Boulder (Schmitt and Cernan, 1973). The exterior surfaces of boulder samples are covered with micrometeorite craters and contain solar flare tracks. An unusual feature of two of the samples, 76015 and 76215, is that they each had a patina covered "lip" that was partially protected from micrometeorite bombardment, which led to the development of an especially dark (thick?) patina.

CONSORTIUM STUDIES

The samples of the boulder blocks at Station 6 were the subject of consortium studies led by W. Phinney (1981). Photos of the boulder surfaces (mapped by Heiken et al., 1973) allowed each sample to be

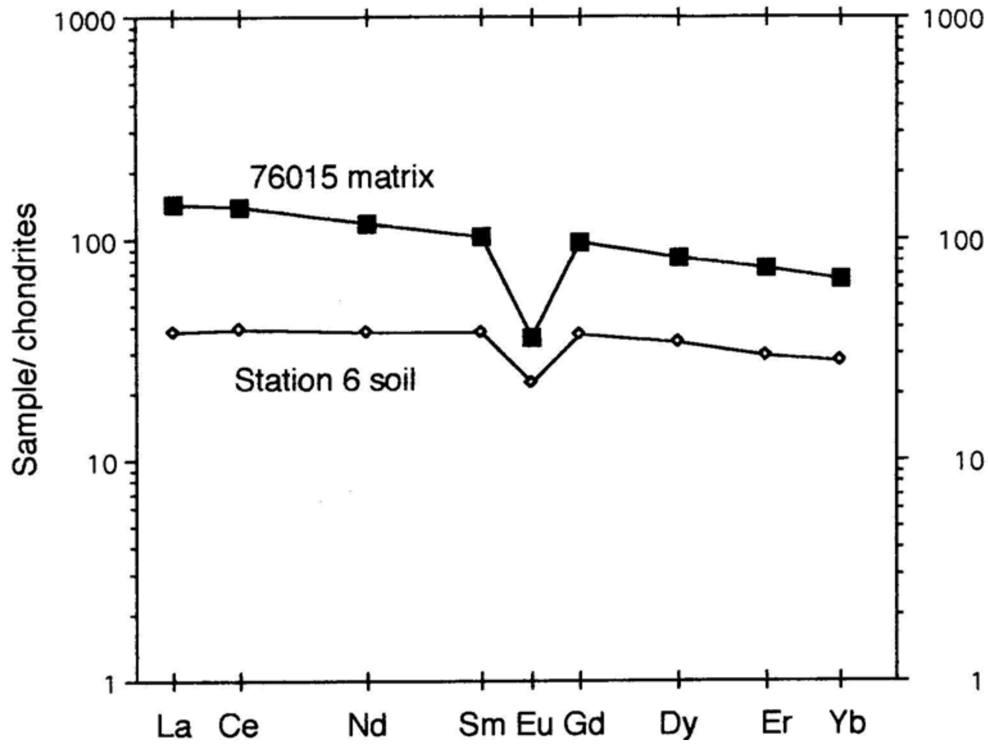

Figure 7: Normalized rare earth element diagram comparing 76015 (typical of boulder) with Station 6 soil.

related to a specific lithology of the boulder. These consortium studies were not completed because many of the samples (i.e., 76275) were slow to be processed and not delivered until after consortium members had left. However, the consortium concluded that the poikilitic texture of these rocks was formed in a melt sheet after the impact (Simonds, 1975; Simonds et al., 1976; and Onorato et al., 1976). This consortium went on to study impact melt sheets in terrestrial impact craters (see JGR 83, 2729-2816).

A summary of the ages of the clasts and matrix samples from the Station 6 Boulder is given in Table 1 from Cadogan and Turner (1976).

There is general agreement that these data (mean age 3.96 t 0.04 b.y.) give the age of the Seren ttatus impact - event (see arguments in Spudis and Ryder, 1981).

A major finding of the consortium was that all the matrix samples were of the same chemical and mineralogical composition (Phinney, 1981). Especially remarkable was the tight grouping in siderophile elements (Higuchi and Morgan, 1975, and Hertogen et al., 1977).

The collection of samples from Boulder 6 provides the most comprehensive set of related samples that has been available for lunar magnetic studies. Gose et al. (1978) carefully studied the remanent magnetization of 26 subsamples from the Station 6 Boulder. The direction of magnetization after alternating field demagnetization of breccia samples was found to be roughly uniform for clast-free matrix samples (76015, 76215) while generally scattered for the clast-rich samples (76275). Gose et al. proposed that the natural remanent magnetization of impact melt breccias is the vector sum of two magnetizations: a pre-impact magnetization and a partial thermoremanence acquired during breccia lithification. The large scatter of magnetization direction of the clast-rich samples implies the predominance of pre-impact magnetization.

Table 1: Summary of Ar 39140 plateau ages from the Station 6 Boulder samples.
Data from Cadogan and Turner (1976).

Sample no.	Irradiation	Plateau age (G.y.)	% ^{39}Ar recoil (matrix samples only)
Matrix samples			
76215,30	SH36	3.94 ± 0.04	0.8
76015,38	SH36	3.93 ± 0.04	1.1
76315,36	SH31	3.98 ± 0.04	1.4
76295,1 (tan)	SH36	3.95 ± 0.04	3.9
76295,3 (blue)	SH36	3.96 ± 0.04	2.4
76275,39	SH40	4.02 ± 0.04	2.9
Clasts			
76235,3	SH36	3.93 ± 0.06	—
76235,3	SH40	3.95 ± 0.06	—
76315,67 (C3)	SH31	3.97 ± 0.04	—
76315,61 (C2)	SH31	3.98 ± 0.04	—
		(4.10 ± 0.05)	
76255,46	SH40	4.02 ± 0.04	—
Mineral concentrates			
76015,38 (plag)	SH36	3.96 ± 0.06	—
76015,36 (plag)	SH36	3.92 ± 0.04	—
76015,38 (px)	SH36	(3.79 ± 0.07)	—
76015,36 (px)	SH36	(3.92 ± 0.09)	—
Mean age		3.96 ± 0.04	