INVESTIGATIONS OF A KREEPY STRATIFIED BOULDER FROM THE SOUTH MASSIF. John A. Wood (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory, Cambridge, Mass. 02138), representing the Consortium Indomitabile.*

The Apollo 17 crew examined and sampled three boulders at the foot of the South Massif (Station 2). One of these, Boulder 1, is structurally and compositionally different from the others, and from all other Apollo 17 samples (except breccia 73215). The Consortium Indomitabile was organized to collaborate in studies of the four rock samples taken from Boulder 1 (72275, 72255, 72235, 72215).

The boulder is distinctly layered, and is composed of a polymict breccia. It was classified in the field as a "blue-gray breccia", and is likely to have originated in the blue-gray geologic unit that caps the South Massif. The cosmic ray exposure age of the boulder, based on charged particle track densities, is about 20 million years.

The bulk composition of boulder material corresponds to that of a moderately KREEPy, noritic rock. Fig. 1 shows that boulder sample 72275 contains more K_2O and P_2O_5 than most other Apollo 17 highland samples, and (unlike the latter) is silica saturated; the entries it falls closest to in this plot are 62235, 15265, and brown glass samples from the Apollo 12 mission.

The significance of this composition is uncertain, however, as the clasts in the boulder samples are extremely diverse in character, running the gamut from low-KREEP anorthositic and noritic types (0.1% K_2O, 46 ppm Ce) to potash granites (8.1% K_2O, 0.7% BaO). One type of dark aphanitic clast material, itself enriched in granitic clasts, contains 220 ppm Ce, 3.5 ppm U, and 11.3 ppm Rb.

The visible stratification of the boulder is due to differences in competence, and resistance to micrometeorite erosion, of the various layers. Samples from a competent layer (72255) and a friable layer (72275) have been studied. The two materials are grossly similar in chemistry, mineralogy, and clast populations, though rare earth elements are more abundant by almost a factor of two in 72275 than in 72255. The difference in compet-

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KREEPy Stratified Boulder
Consortium Indomitabile

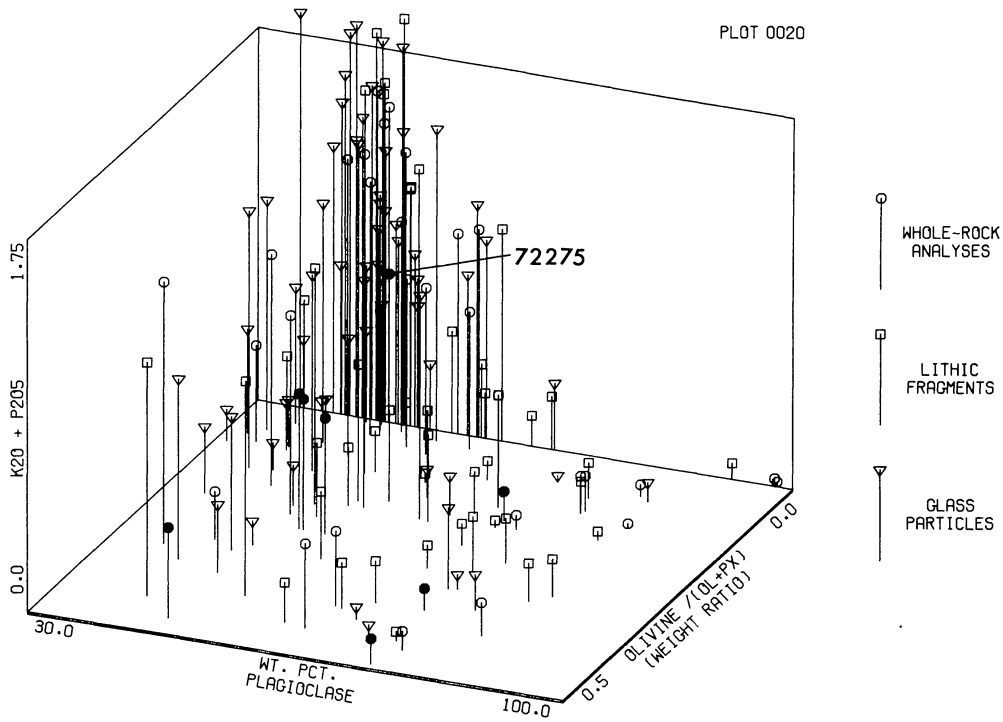

Figure 1. Chemical and (normative) mineralogical properties of a sampling of highland materials from all the lunar missions. Filled circles, Apollo 17 samples.

ence appears to reflect a difference in the degree of thermal sintering experienced after the breccias were deposited in their present configuration. (Limited eutectic melting along grain boundaries in granite clasts of 72255 points to a sintering temperature of 990° ± 20°C.)

We have not yet determined the metamorphic age of the boulder. U-Th-Pb studies show that some components of the boulder are very old (possibly as old as 4.55 x 10^9 years). A Rb-Sr isochron age of 4.18 ± 0.04 x 10^9 years, and an initial $^{87}Sr/^{86}Sr$ ratio of 0.69922 ± 0.00005, have been determined for one particular clast (the "civet cat", a low-KREEP coarse-grained norite) in 72255. This is interpreted to be the igneous age of the norite. The civet cat norite is essentially devoid of the trace elements that are characteristic of a meteoritic component, so presumably was derived from a depth beneath the ancient highland regolith.

The vector direction of Natural Remnant Magnetization (NRM) in samples from 72275 was found to be antiparallel to the NRM

vector in samples from 72255. It appears that a reversal in the lunar magnetic field occurred between the times when the two layers represented by 72275 and 72255 cooled beneath the Curie temperature of metallic iron. This would imply that the layers in Boulder 1 were deposited over a long period of time, since the terrestrial dynamo field takes ~5,000 years to reverse polarity.

Petrographic and chemical similarities between the layers sampled make it seem likely that they are composed of debris from the same cratering event, however, and therefore that they were deposited at essentially the same time. (This would require that the magnetizing field was due to something other than a core dynamo.) The boulder is widely held to consist of stratified debris from a basin-forming impact, but we have not agreed upon the source basin. Prime candidates are:

(a) Serenitatis, because of its proximity

(b) Imbrium, because of the chemical similarity of the boulder samples to Imbrium-related materials

(c) Crisium, on the basis of patterns of meteoritic trace element abundances (in the context of trace element patterns in samples from all the lunar sampling points).

The reader is referred to Interdisciplinary Studies of Samples from Boulder 1, Station 2, Apollo 17 (a document distributed by the Consortium Indomitabile during the Fifth Lunar Science Conference) and to abstracts of Consortium members in Lunar Science V, for more detailed descriptions of boulder samples.