

turn is clearly disproven. Similarly the theory that CNV and the P300 effect reflect the action of a common "activation" mechanism must be rejected. It is likely that all EEG activity is correlated with the gross arousal level of the subject and that this common element may introduce covariances between different phenomena derived from the EEG. But another process is required to explain the dissociability of CNV from the P300 effect. Apparently there are at least two independently variable modulators of cortical electrical activity correlated with moment-to-moment efficiency in human performance. Although these data are not addressed directly to Nataanen's (6) or Karlin's (4) speculations about the psychological processes underlying CNV and the P300 effect, such speculation must now account for the independent variability of these two phenomena.

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12. For the identification task a 0.1-msec warning click was followed 2 seconds later by a 32-msec tone pip of either 1000, 1100, 1200, 1300, 1400, or 1500 Hz, which the subject identified by pressing one of six corresponding keys. A click train (15 cycle/sec) immediately followed the offset of the tone pip; this train could be terminated immediately by a correct key press; a response delayed more than 3 seconds was recorded as a failure, and the click train was automatically terminated. The click train made the task more difficult by partially masking the tone, and its immediate termination indicated a correct response. Responses and failures were recorded on a teletype printout.
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14. Beckman Instruments, Inc., Fullerton, Calif. Polarization voltage stabilized at approximately 0.25 μ V/hour within 20 minutes after application. For d-c recording, electrode impedances were kept below 2500 ohms.
15. Topography data on five of the subjects indicated that in this paradigm the foreperiod CNV is largest at the vertex, falling off sharply in amplitude at P_z, T_z, T₄, and FP electrodes (International 10-20 System).
16. On about 20 percent of the recording sessions a steady baseline drift persisted throughout the experiment. On these occasions the baseline slope was calculated and subtracted from the averaged records in the quantification procedure. This permitted a more accurate measurement of CNV amplitude than would have been possible if amplifier time constants had been used. Large irregular baseline changes were occasionally observed; these were usually due to movement artifact which could be eliminated by keeping electrode impedances below 3 kilohms.
17. W. J. Dixon and F. J. Massey, Jr., *Introduction to Statistical Analysis* (McGraw-Hill, New York, ed. 2, 1957), p. 126.
18. Compare J. Tecce and N. Scheff, *Science* **164**, 331 (1969) and C. McCallum, in *Attention in Neurophysiology*, C. R. Evans and T. B. Mulholland, Eds. (Butterworths, London, 1969), p. 40. Both references report CNV blocking by distracting stimuli. Such blocking was not observed here, presumably because no task-irrelevant operations were linked to the shock stimulus.
19. The ratios of R to IR for P300 and CNV were calculated from measurements of amplitudes from base to peak.
20. Figures 2B and 2C suggest a positive within-condition correlation between CNV and P300 amplitude on R trials. In fact, although no subjects yielded significant Spearman rank correlations between CNV and P300 on IR trials, three of the six subjects did yield significant ($P < .05$) correlations on R trials. Since performance of the task requires attention to the shock on R trials, but not on IR trials, these correlations probably reflect the established covariance of both P300 on IR trials, three of the six subjects within conditions (4, 8). This covariance would not be predicted in the IR condition since the P300 wave to the shock is unrelated, whereas CNV is related to performance efficiency. In any case, the within-condition correlation is borderline and gross variations in stimulus significance across the R and IR conditions, although not altering CNV amplitude, introduce P300 changes so large as to destroy any absolute proportionality between CNV and P300.
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Potassium-Uranium Systematics of Apollo 11 and Apollo 12 Lunar Samples and of Some Deep Earth Rocks

Fanale and Nash have discussed the K-U systematics of lunar, chondritic, and terrestrial samples (1). They discerned distinct trend lines for Apollo 11 and Apollo 12 samples and for ter-

restrial rocks and showed that chondrites are not members of these trend lines. They pointed out that, if the earth and the moon were formed from the same material, then the lunar rocks

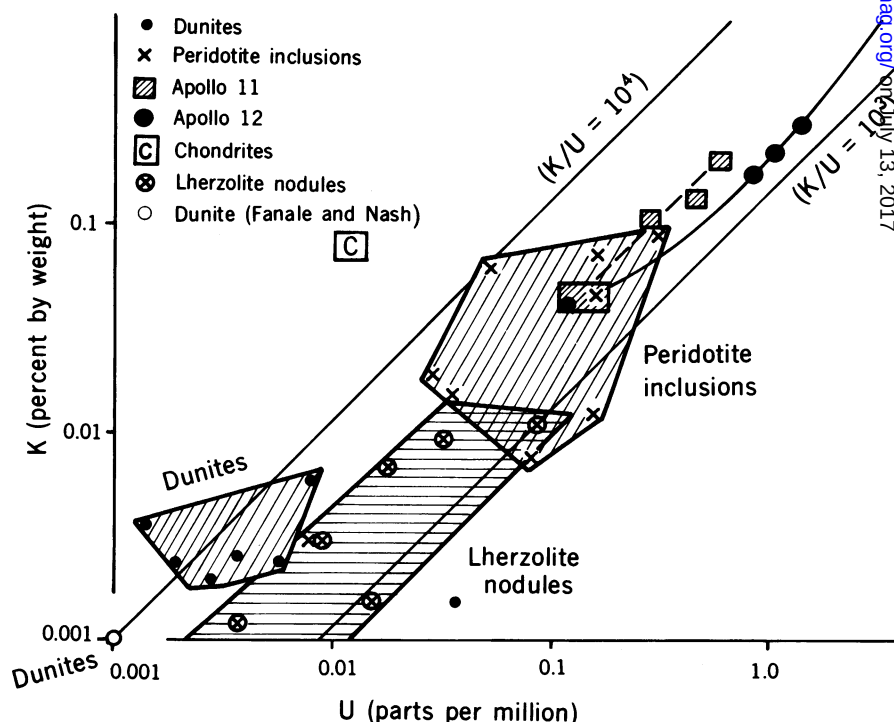


Fig. 1. Potassium-uranium systematics for lunar, chondritic, and terrestrial samples. Lunar data from figure 1 of Fanale and Nash (1) (see their references for original data); chondritic data from Fisher (5); dunite and peridotite data from Fisher (2); lherzolite data from Green *et al.* (3).

which thus far have been analyzed must be "enriched" in both U and K, and we must search for "depleted" lunar material which would enable the trend lines to be extrapolated to the left in Fig. 1 so that they cross that of the earth at some material balance point.

Figure 1 of Fanale and Nash (on which Fig. 1 is based) shows all the terrestrial data lying along the $K/U = 10^4$ line. This is an oversimplification based on incomplete data. In Fig. 1 I show some recent K/U data for ultramafic rocks (2, 3). These types of rock are not unimportant in a consideration of the total chemical makeup of the earth; it is generally considered that either the peridotite inclusions in basalt or kimberlite or the lherzolite nodules shown here are the best approximations to mantle rocks that we have at the present time. Also shown in Fig. 1 are some dunite data. Dunites are most probably the residue from the differentiation of mantle material into basalts. For comparison, the dunite point quoted by Fanale and Nash from the data of Tilton and Reed (4) is shown; this point was based on only one K datum and on U data for only two rocks (for which Tilton and Reed specified that, because of contamination and analytic difficulties, the data should be used only as limits to the actual U concentrations).

The data of Fig. 1 show clearly that the lunar K and U abundances already observed in the Apollo 11 and Apollo 12 samples are well within the range found in terrestrial peridotite inclusions in basalt and kimberlite. The lunar K/U ratio of about 3×10^3 is the same as that in both the peridotite inclusions and the lherzolite nodules. Therefore the data available at present are in agreement with the notion that the earth and moon both accreted in the same portion of the pre-solar-system cloud. These data do not compel one to believe that there must exist a "huge reservoir of ultramafic 'depleted' phases" with $K/U > 10^4$ (1, p. 283) among the as yet unexplored lunar regions. The conclusion of Fanale and Nash that chondrites accreted in a different portion of space remains valid.

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6. Research supported in part by NSF grant GA 24785. Contribution No. 1352 from the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

1 February 1971

The new data on the ratio of K to U in ultramafic rocks presented by Fisher constitutes a valuable addition to our knowledge of the K-U systematics of the earth. His conclusion that "the data available at present are in agreement with the notion that the earth and moon both accreted in the same portion of the pre-solar-system cloud" is identical with our original conclusion, namely, "Thus differences between the K/U ratios of Apollo samples and crustal rocks of the earth do not preclude the possibility that the moon and the earth were derived from materials possessing the same K/U ratio." (1, p. 283).

On the other hand, we disagree with Fisher's conclusion that "These data do not compel one to believe that there must exist a 'huge reservoir of ultramafic 'depleted' phases' . . . among the as yet unexplored lunar regions." As we emphasized in our report, the fact that Apollo samples are highly differentiated is obvious from their U contents, which are from 20 to 600 times those of chondrites. Chondrites are normally assumed to exhibit roughly the relative abundances of non-volatile elements of the initial solar system. No mechanism except magmatic differentiation has ever been suggested which could produce such an enormous enrichment in uranium (including preaccretion heating). Material balance dictates that a much larger corresponding reservoir of material depleted in K and U must exist, probably at depth on the moon. Whether some magmatic differentiation of lunar material occurred prior to hypothetical fission from the primitive earth remains essentially an open question. But in this connection we should also consider the argument that, if the moon throughout its volume has always possessed a uranium con-

tent equal to the average of the Apollo samples, the moon would almost certainly be molten throughout at the present time, which does not appear to be the case.

The recent discovery of a glass rich in potassium, rare earth elements, and phosphorus ("KREEP"), simultaneously reported by several groups of workers at the Apollo 12 conference in Houston in January 1971 (2), together with further studies of rock 12013 (3), suggests to us an additional interpretation of one aspect of the data. It now appears that the Apollo 11 and 12 samples may represent U- and K-enriched members of essentially the same differentiation sequence, and that magmatic processes that produced siliceous material such as rock 12013 may also have enriched such material in U relative to K.

This process may be analogous to the apparent enrichment in U over K in granitic, relative to basaltic, rocks on earth [figure 1 in (1)]. Such an interpretation would also be consistent with our conclusion that "the two suites appear to have been derived from materials of identical potassium and uranium content" (1, p. 282). In any case, this would not affect our conclusions concerning the relationship between the bulk K/U ratios of terrestrial, lunar, and chondritic material.

Subsequent to the publication of our report, it was brought to our attention that Tera *et al.* (4) have discussed the K-U systematics of the Apollo 11 samples and have pointed out that both U and K are probably highly concentrated in interstitial glassy material.

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