Our familiarity with continental magnetic structures, in both large and fine scale, is, in fact, what led us to develop the methods we are using and to be well aware of the substantial differences between the oceanic and continental situation. In particular, the carefully mapped, highly lineated large-scale magnetic patterns in the northeastern Pacific (*1*), the recognition of strikingly similar sea-surface magnetic profiles in other far-distant locations (*2*), the lack of ancient rocks (older than 150 million years) in the ocean basins, and the petrographic uniformity exhibited by the East Pacific Rise (*3*) are all circumstances which those familiar with both sea and land data realize occur only in the oceanic environment.

The fine-scale magnetics, only part of the new data presented (*4*), are not surprising. They have been seen in nearly all of our near-bottom magnetometer tows (*5*) and show a strong tendency toward lineation of the same orientation as the large-scale features where these coexist. Explaining these details in a manner consistent with all the above data was the problem we faced (*4*).

Finally, the use of continental paleomagnetic data, gathered and analyzed by geologists concerned with the origin of rock units and the conditions at the time of their emplacement, provided the first clear evidence of magnetic-field reversals, including the time scale of these events based on potassium-argon dating methods (*6*).

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Whitetop Experiment

In the article "Areal spread of the effect of cloud seeding at the Whitetop experiment," Neyman, Scott, and Smith (*Science*, 28 March 1969) clearly show that there was less rain on days with seeding than on days without seeding. Neyman *et al.* do not make a good case for their implied conclusion that the deficiency of rainfall, over an area of radius 180 miles, was caused by the cloud seeding. Throughout the article, it is suggested that the deficiencies were in fact a "decrease" and were caused by seeding. One reads on page 1446, "Figure 2 was constructed to bring out more clearly the continuity of the effect of seeding. . . ." Tables 1 and 2 are entitled "Estimated effects of cloud seeding. . . ."

The two-tailed significance levels in the two tables are not so small as to make it self-evident that the rainfall differences were caused by seeding.

Several hypotheses might be offered to explain effects of seeding downwind of the seeding area, but no plausible hypothesis has been offered to explain effects upwind and to the side to distances of 180 miles. Before concluding the analyses ". . . indicate strongly not only that cloud seeding can affect rain, but also that its effect can spread over very large areas . . . ," the authors should have sought other explanations for the observed differences in rainfall. Specifically, it is essential to examine whether the rainfall differences can be ascribed to meteorological differences having nothing to do with the seeding. Summer rainfall sometimes occurs in the form of widely scattered showers and thunderstorms. On other occasions, organized zones of thunderstorms extending over hundreds of miles may sweep along and produce heavy and widespread rainfall. Is it possible that, in the sample of days without seeding, notwithstanding the randomization, there were more occasions of widespread, convective cloud systems which produced rainfall over almost the entire area shown in Neyman's Figure 1? Were the differences in percentage of rainfall a result of a few days without seeding with unusually heavy rainfall over most of the area? Until these questions can be answered, it is premature to suggest that rainfall differences over an area 180 miles in radius were caused by cloud seeding. In conclusion, we agree with Neyman *et al.* about the need for more research aimed at resolving the many uncertainties about the effects of cloud seeding.

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The principal message of our article is concerned with the question of whether the verifiable numerical results of the Whitetop experiment support the frequent claims that cloud-seeding technology is sufficiently developed to justify federal expenditures on large-scale operations intended to alleviate water shortages. Earlier studies of the Whitetop trial are all agreed that the average instantaneous precipitation within a small variable area labeled Missouri Plume, observed on days with seeding, was about one-half that on days without seeding and that this difference is highly significant. We supplemented these findings by studying the 24-hour precipitation in six concentric regions, up to a distance of 180 miles. We found that in all these regions the precipitation on seeded days was always less than that without seeding. "The estimate of the average seeding effect in the entire region is a 21-percent loss of rain. *In the absence of a real effect, chance alone could produce such an estimated loss, or a larger one, about once in 15 independent trials.*" (Italics added.)

This was our principal finding. Battan is certainly entitled to his opinion that "significance levels . . . are not so small as to make it self-evident that the rainfall differences were caused by seeding." In fact, we agree about the lack of self-evidence. But, if there is anything in the contention that a gain in the rainfall of 5 to 10 percent is worth talking about, then a 20 percent loss, experienced over a vast area of some 100,000 square miles, must be a disaster. In these conditions, the odds of 14 to 1 that this loss was caused by seeding do not appear negligible to us. We feel that it is imperative that the general public and the government be informed of the situation.

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