Letters

Pseudoscopic Illusion

That visual perception of surface relief can easily turn Mayan moats into raised mounds, steep-sided Arctic basins into flat-topped mesas, or even the "Grand Canyon of Mars" into an extended dome mountain, may surprise unwary readers of *Science*. We refer specifically to illustrations accompanying an interpretation in the article by R. T. Matheny of ancient hydrographic modifications in Mexico (20 Aug., p. 639, figure 5), a comparison by L. W. Gatto and D. M. Anderson of martian fretted terrains with flat-floored thermokarst valleys in Alaska (Reports, 18 Apr. 1975, p. 255, figures 2 and 3), and a report by L. A. Soderblom on Viking 1 orbiter images of Mars (Reports, 1 Oct., p. 97, especially the cover picture).

It is possible to rectify these distorted impressions by viewing the illustrations upside down (for example, Figs. 1 and 2). Indeed, almost all instances of this type of pseudoscopic illusion (apparent reversal of surface depressions and elevations) in vertical aerial photography can easily be avoided by careful orientation of prints before publication. A useful convention, dictated not by editorial policy but by the way we see shaded relief, is simply to position each photograph so that heavy shadows fall more toward the bottom than toward the top margin.

Because illumination of familiar environmental features comes mostly from directions other than below our horizontal line of sight, we readily interpret unfamiliar views of textured surfaces represented in continuous-tone vertical photographs as if shadows were cast toward the bottom or either side of the displayed imagery. This leads to a frequently perceived reversal when such an illustration is placed so that actual shadows extend upwards ("away from the viewer"). Additional variables affecting this visual ambiguity include: resolution and other technical qualities of the photography, planimetric scale of representation, depth and form of relief, location and source of illumination, and the initial degree of the viewer's unfamiliarity with the subject matter or mode of presentation.

This widely experienced phenomenon has been the subject of experimental and technical discussion in psychology, photogrammetry, and allied fields for some time (*1*), but it apparently remains less universally recognized by users of vertical imagery.

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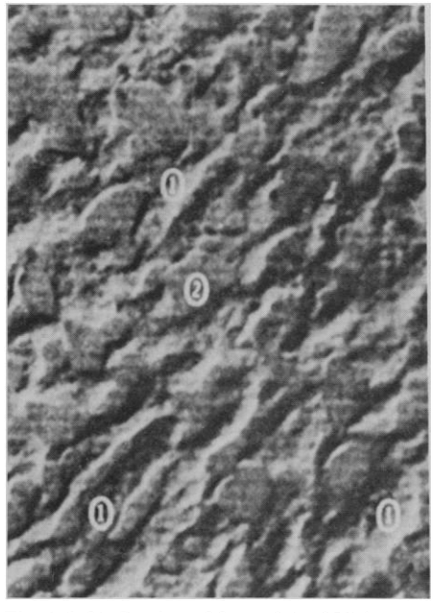
References

1. J. J. Gibson, *The Senses Considered as Perceptual Systems* (Houghton Mifflin, Boston, 1966), pp. 208–209; R. L. Gregory, *Eye and Brain, The Psychology of Seeing* (McGraw-Hill, New York, ed. 2, 1973), pp. 185–187; R. M. Evans, *An Introduction to Color* (Wiley, New York, 1948), pp. 150–152, figures 9.25 and 9.26; J. L. Ridgeway, *Scientific Illustration* (Stanford Univ. Press, Stanford, Calif., 1938), p. 14 and plate III; A. H. Robinson and R. D. Sale, *Elements of Cartography* (Wiley, New York, ed. 3, 1969), p. 81; A. L. Nowicki, in *Manual of Photogrammetry*, M. M. Thompson, Ed. (American Society of Photogrammetry, Falls Church, Va., ed. 3, 1966), pp. 523–524; J. Estes, in *Manual of Remote Sensing:* vol. II, *Interpretations and Applications*, L. W. Bowden, Ed. (American Society of Photogrammetry, Falls Church, Va., 1975), p. 893.



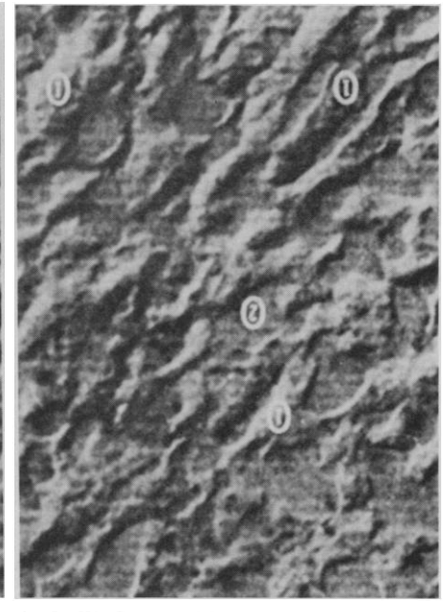


Fig. 1 (left). Portion of figure 3 (p. 256) in report by L. W. Gatto and D. M. Anderson (18 Apr. 1975, p. 255) showing Alaskan thermokarst terrain; *1*, uplands; *2*, basin. Fig. 2 (right). Same photograph viewed upside down.

Coal Research: Progress and Problems

The article by Allen Hammond "Coal research (I): Is the program moving ahead?" (Research News, 20 Aug., p. 665) discusses the coal program of the Energy Research and Development Administration (ERDA) and emphasizes the commercial feasibility of technology being established in large-scale pilot plants. He correctly points out that a fundamental difficulty is the high cost of clean energy from coal. This is followed by some historical background and reporting of the comments by some that the present status of the U.S. coal program is not very satisfactory.

Issue could be taken with these negative comments, as they do not take into account the funding and political constraints imposed during the past two decades. In the period from 1950 to the early 1970's, there was a minimal and inadequate effort on coal conversion R & D. The combined budget for the Bureau of Mines and the Office of Coal Research in 1970 was only $20 million, and less than this was expended by indus-