LETTERS

Landsat's Role in Brine Discovery

In his Research News article of 29 April "Remote sensing (I): Landsat takes hold in South America" (p. 511), Allen L. Hammond attributes the recent discovery of lithium- and potassium-rich brines in Bolivia to analysis of Landsat imagery. This statement should be clarified. The brines were discovered in Salar de Uyuni, which is a 9000-square-kilometer salt pan in the southern part of the Bolivian Altiplano and the largest hard, flat surface on Earth. The suggestion that lithium- and potassium-rich brines might occur in this salar was first made in a paper (*1*) presented at a symposium on lithium in Denver in January 1976. The paper was based primarily on an evaluation of the environment of lithium- and potassium-rich brines in salars of nearby northern Chile. As a consequence of this work, brine samples were collected by a Landsat team that visited Salar de Uyuni in April 1976 for the purpose of gathering data about the salar surface to aid in interpreting patterns recorded by Landsat. Two samples collected and analyzed in laboratories of the U.S. Geological Survey proved to be high in lithium and potassium.

GEORGE E. ERICKSEN
U.S. Geological Survey, Reston, Virginia 22092

References

1. G. Ericksen, G. Chong, T. Vila, *U.S. Geol. Surv. Prof. Pap. 1005* (1976), p. 66.

Nighttime Driving Accidents and Selective Visual Degradation

It has been established that the incidence of serious traffic accidents, particularly those involving pedestrians, increases at night (*1*). While variables such as fatigue and drinking behavior are more prevalent at night, and variation in traffic flow may be important, the striking reduction in the nighttime accident rate as a result of illuminating highways argues for the importance of vision (*2*). In view of the significance of visual factors, the influence of low illumination on specific aspects of driver performance merits further attention. In this context, the recent emphasis on multiple modes of visual information processing provides a heuristic basis for analyzing the driver's perceptual-motor tasks (*3–5*). According to this point of view, visual processes can be dissociated into at least two subsystems. "Focal" vision is mediated primarily by the central retina and subserves form perception (identification), while "ambient" vision is mediated primarily by the peripheral retina and provides information regarding spatial localization. These processes differ with respect to their subserving neurological structures (*3*), modifiability (*4–5*), sensitivity to blur (*6*), degree of consciousness, temporal courses, and luminance response characteristics (*7–8*), all of which suggest physiological as well as behavioral dissociation of function.

Held (*4*) has suggested that localization and mobility in space are primarily dependent on the ambient peripheral system, and Dichgans and Brandt (*9*) have shown that peripheral vision is of great importance, both for the perception of body orientation and motion and for the control of posture. Since the automobile driver's primary task, which demands his immediate and continuous attention, is dynamic spatial orientation, one would expect this activity to be mediated mainly by the peripheral retina. It has been established that peripheral localization is independent of target luminance (*7*), that resolution acuity in the periphery is relatively unaffected by optical blur (*6*), and that dynamic spatial orientation is independent of both luminance and refractive error. Thus, there should be relatively little degradation of performance of the ambient system with lowered illumination. The driver should suffer little or no loss of steering ability under low illumination and his self-confidence should remain high. Therefore, he might neglect taking appropriate precautions at night. Such behavior is consistent with reports that drivers generally do not reduce their speed at night and with clinical observations that many individuals with central scotomata continue to drive (*10*).

In contrast with the relatively high level of performance of the ambient system, the performance of the focal (form identification) system is seriously degraded under low illumination. Major visual functions, such as resolution acuity, contrast sensitivity, and stereoscopic depth perception, are reduced substantially at lower luminance levels. In addition, darkness-induced refractive errors or "night myopia" will, for many individuals, increase the blur of the optical image and further reduce performance for those functions requiring a sharp retinal image (*11*). Such blurring will also hinder the detection of dim stimuli (*12*), which is of great importance to the driver at night. While some stimuli containing important information, such as pavement markings, road signs, and other traffic, are usually sufficiently illuminated to be easily seen under favorable weather condi-

tions, other less predictable but equally important stimuli, such as pedestrians, cyclists, and disabled vehicles, are often only dimly illuminated, resulting in hazardous situations. Due to the blurring as a result of night myopia, the detection and recognition of such dimly lit obstacles may be delayed until the braking or evasive maneuvers necessary to avoid an accident are impossible.

Since the major tasks of driving are relatively unimpaired by reduced illumination, the driver does not anticipate and is not prepared to deal with stimuli for which the focal system suffers a selective deficit. In effect, the driver is unjustifiably reassured by the high performance level of the dynamic spatial orientation system and is unaware of a loss in focal visual abilities. Since the visual deficit is only partial and of consequence only for low-probability stimuli, the driver is unaware of the loss of function and does not take the necessary precautions. In contrast to such naive overconfidence, drivers who are aware of their visual loss, such as those with incipient cataracts (*13*) or with small pupils associated with glaucoma therapy, are reluctant to drive at night.

Several precautions can be taken to improve this situation. An obvious one would be to increase the visibility of unexpected obstacles by continued efforts to improve roadway illumination and by increased usage of highly reflective markings. A more general and presently unused measure would be to screen drivers for night-time as well as daytime visual performance and to optimize their abilities by providing optical corrections at night when necessary. In the past, the cause and correction of night myopia have been topics of some controversy. However, recent studies from this laboratory, which attribute night myopia to a shift in ocular accommodation toward the individual's resting or dark-focus (*Akkommodationsruhelage*), suggest a simple method for counteracting the loss of image clarity at night. An evaluation of the dark-focus with a laser optometer has permitted us to recommend an individually determined optical correction specifically for night myopia which substantially improves form perception under both laboratory and field conditions (*14*). In a small sample of college students, this correction was found to improve visual acuity by as much as 25 percent under simulated night-time driving conditions; similar improvements for the detection of weak stimuli would be expected. At highway speeds this added margin of visibility could weigh heavily in the interest of accident prevention. It is hoped that awareness by drivers and traffic safety authorities of the selective nature of the visual losses at night will provide the basis for measures to reduce the appalling frequency of accidents at night.

H. W. LEIBOWITZ, D. A. OWENS
Department of Psychology, Pennsylvania State University, University Park 16802

References and Notes

1. M. Becker, *Road Saf. Cent. Publ. No. 7515* (Technion, Haifa, Israel, 1971); S. Widen, *Report No. 56* (National Swedish Road and Traffic Research Institute, Stockholm, 1974).
2. B. Gramberg-Danielsen, *Sehen und Verkehr* (Springer-Verlag, Berlin, 1967), pp. 110–112.
3. G. E. Schneider, *Science* **163**, 895 (1967).
4. R. Held, *Psychol. Forsch.* **31**, 338 (1968); in *The Neurosciences: Second Study Program*, F. O. Schmitt, Ed. (Rockefeller Univ. Press, New York, 1970), pp. 317–324.
5. ———, in *Visual Sciences*, J. R. Pierce and J. R. Levene, Eds. (Indiana Univ. Press, Bloomington, 1971), pp. 197–204.
6. M. Millodot, C. Johnson, A. Lamont, H. Leibowitz, *Vision Res.* **15**, 1357 (1975); C. A. Johnson, H. W. Leibowitz, M. Millodot, A. Lamont, *Percept. Psychophys.* **20**, 460 (1976).
7. H. W. Leibowitz, N. A. Myers, D. A. Grant, *J. Opt. Soc. Am.* **45**, 76 (1955); *J. Exp. Psychol.* **50**, 369 (1955).
8. H. Leibowitz and J. Dichgans, *Umsch. Wiss. Tech.* **77**, 353 (1977).
9. J. Dichgans and T. Brandt, in *The Neurosciences: Third Study Program*, F. O. Schmitt and F. G. Worden, Eds. (MIT Press, Cambridge, Mass., 1974), pp. 123–129.
10. L. L. Sloan, personal communication; R. E. Hoover, personal communication.
11. H. W. Leibowitz and D. A. Owens, *Science* **189**, 646 (1975); *J. Opt. Soc. Am.* **65**, 1121 (1975).
12. F. Fankhauser and J. Enoch, *Arch. Ophthalmol.* **86**, 240 (1962).
13. M. Allen, *Vision and Highway Safety* (Chilton, Philadelphia, 1970), pp. 93–96.
14. D. A. Owens and H. W. Leibowitz, *Am. J. Optom. Physiol. Optics* **53**, 709 (1976).
15. Sponsored by NIMH grant MH08061.

Is Small Always Beautiful?

I would like to add one more note to the many that have undoubtedly been received concerning the use of natural gas, uncoated, nonglossy paper, or coated paper in the production of *Science*. In the 1 April issue the increased costs related to using the uncoated paper were provided, not the least of which is the environmental impact of producing the extra 16 tons of paper required for the 11 February issue. By imposing the single criterion of "low cost," it has been determined that a coated, glossy paper should be used. The significant point is that these coated papers are the result of "high technology."

Thus we have a dramatic example that the "small is beautiful" philosophy and its "intermediate technology" do not always provide the best solution; nor do they implicitly improve the quality of life, save natural resources, or protect the environment.

DANIEL D. WHITNEY
Rancho Seco Nuclear Generating Station, Sacramento Municipal Utility District, Sacramento, California 95813