follows the response. Avoidance behaviour cannot, therefore, be simply interpreted in terms of the secondary reinforcing effects of the removal of an exteroceptive warning stimulus, but must make reference to the stimulus compound both before and after a response is made.

We wish to acknowledge our indebtedness to the Rockefeller Foundation which supported this investigation through a grant to the Arts and Sciences Division of the American University of Beirut.

J. D. KEEHN
SANNIYAH NAKKASH
American University of Beirut,
Beirut, Lebanon.

[1] Brogden, W. J., Lipman, E. A., and Culler, E., *Amer. J. sycho.* **51**, 109 (1938).
[2] Gibson, E. J., *J. Comp. Physiol.*, **45**, 18 (1952).
[3] Mowrer, O. H., and Lamoreaux, R. R., *Psychol. Monogr.*, **54**, No. 5 (1942).
[4] Kamin, L. J., *J. Comp. Physiol. Psychol.*, **50**, 450 (1957).
[5] Mowrer, O. H., "Learning Theory and Personality Dynamics" (Ronald, New York, 1950).
[6] Skinner, B. F., "Science and Human Behaviour" (Wiley, New York, 1953).
[7] Sidman, M., *Science*, **118**, 157 (1953).

ARCHAEOLOGY

Pleistocene Climatic Significance of Calcretes and Ferricretes

CALCRETES and ferricretes are widespread features of African soils. They have attracted attention from both soil specialists and archæologists, for they frequently occur in soil profiles containing Stone Age artefacts and fossils. The calcretes and ferricretes have been generally assumed to have climatic and stratigraphic significance. Archæologists and geologists have dated them in terms of associated artefacts or fossils, just as other geological horizons are dated by *in situ* cultural or organic objects. R. F. Flint[1] has summarized recent views on the climatic interpretation of ferricretes and calcretes. Flint suggests that ferricrete formation requires rainfall 'above a certain minimum', stating that ferricretes "seem to indicate Pleistocene climates that were wetter than those of to-day, provided Pleistocene age is established", while calcretes imply low rainfall, perhaps less than 18 in. (45·6 cm.) per annum.

An interpretation of this kind was given to the soil profile at the Skoonheid 1529 Later Pleistocene archæological site, long. 29° 27′ E., lat. 24° 7′ S., 40 miles (64·7 km.) east of Potgietersrus in the Central Transvaal. Here an erosion gulley has exposed Stone Age artefacts in a way frequently found in Africa. A number of archæologists and geologists agreed with the observation and climatic deductions set out by one of us[2], but soil specialists found they could not accept the interpretation. Accordingly, we returned to the site in May–June 1959 for a fortnight's field study. We excavated a number of sections in the gulley and examined borehole profiles drilled for the purpose adjacent to the gulley.

The excavations showed that ferricrete concretions are scattered throughout the profile, though they are concentrated in the horizons given in ref. 2. Contrary to the views expressed there, these 'ferruginized zones' have no Pleistocene stratigraphic or climatic significance. For example, "Ferruginised Zone 2" both underlies and overlies the same Pleistocene Stone Age horizon at different parts of the site. "Ferruginized Zones 2 and 3" must have formed recently, when the entire soil profile was established but before erosion of the present gulley. The occurrence of all "ferruginized zones" at the site in Stone Age horizons is purely coincidental, for they formed tens of thousands of years later than the dates of the artefacts they encase.

Ferricrete may be seen actively forming in some parts of the gulley floor to-day, where water seepage along the granite bed-rock surface is producing a sesquioxide sheet or ferricrete in the overlying permeable sediments under impeded local drainage[3]. This recent ferricrete has cemented ancient Earlier Stone Age gravel in other parts of the site, thus—assuming a quite misleading age. Elsewhere on the site, excavation proved that the same gulley floor ferricrete, named "Ferruginized Zone 1" in ref. 2, lies several feet above the Earlier Stone Age gravels, clearly showing its more recent origin. In ref. 2 it was assumed that "Ferruginized Zone 1" formed immediately after Earlier Stone Age but its origin post-dates formation of the present gulley. In June 1959, at the height of the local dry season, ferricrete concretions appeared to be forming continuously in one part of the gulley floor where nocturnal water seepage to the surface ceased during the day.

Like ferricrete concretions, calcrete concretions also occur throughout the profile, but not in the limited horizons stated in ref. 2. Calcrete formation has continued in the less permeable horizons throughout the history of the profile, from Earlier Stone Age times to the present day, concurrently with ferricrete formation. To-day the area receives 21 in. (53·25 cm.) of rainfall per annum, while daily average temperature varies from 80° F. (27° C.) to 36·6° F. (2·6° C.), so at Skoonheid it is clear that ferricretes and calcretes reflect soil climate, not external climate. Wet conditions are necessary for the formation of ferricretes, but these occur within the soil itself, not above it. Soil evidence at Skoonheid 1529 therefore gives new evidence of the wide range of variation of conditions favouring ferricrete and calcrete development. Finally, study of the stratigraphy of the site in relation to present river action in the nearby Chunies River suggests that sedimentation on the site may have been controlled by the nearby gap in the Strydpoort Mountains known as Chuniespoort, and need have no relation to Pleistocene climatic change. The climatic interpretations and correlations set out in ref. 2 are accordingly withdrawn. The Pleistocene climatic and stratigraphic value of the calcretes and ferricretes at the Skoonheid 1529 profile have now been placed in truer perspective. There is little doubt that archæological interpretations of these features elsewhere in Africa should be reviewed in this light.

The work at Skoonheid is part of the Archæological Survey's Cave of Hearths–Makapan Valley project generously supported by the Wenner-Gren Foundation for Anthropological Research.

R. J. MASON
Archæological Survey of the Union of South Africa.
A. B. A. BRINK
Pretoria.
K. KNIGHT
Department of Civil Engineering, University of the Witwatersrand.

[1] Flint, R. F., *Bull. Geol. Soc. Amer.*, **70**, 343 (1959).
[2] Mason, R. J., *S. Afr. Archaeol. Bull.*, **14**, 3 (1959).
[3] Loxton, R. F., Division of Chemical Services, Union Department of Agriculture, Technical Services (personal communication).