The WN etch should introduce a sparkle in the work of trackologists who, to their disappointment, have discovered that the bulk of the mineral grains in an extraterrestrial sample is often composed largely of olivine, a mineral which has resisted previous attempts to reveal proper tracks.

S. KRISHNASWAMI
D. LAL, N. PRABHU
A. S. TAMHANE
Tata Institute of Fundamental Research, Bombay, India

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Duricrusts and Deep-Weathering Profiles in Southwestern Wisconsin

Abstract. *Numerous exposures in southwestern Wisconsin display the profiles of relict deep weathering. Crusts are mainly siliceous, but many are ferruginized to some extent. The occurrence of blocky silcrete, thought to be reported for the first time, recalls the profiles in the Australian belt of transition from silcrust to ferricrust. The humid-tropical kind of pedogenesis necessary to effect this transition may have operated as late as the mid-Miocene. In some localities, the action of groundwater has caused crusting, mottling, and reduction beneath the dolomite of former tower karst.*

Duricrusts and deep-weathering profiles (*1*) are exposed in numerous sections in southwestern Wisconsin, over an area of 13,000 km² (5,000 mi²) or more. They transgress the local sedimentary succession, from not lower than the St. Peter sandstone, near the base of the Champlainian series (Ordovician), to well down into the Cambrian. The profiles include pallid zones in their lower parts, with mottled zones next above, and duricrusts at the top, being wholly comparable in their field characteristics and relationships to the profiles and crusts abundantly described from the Southern Hemisphere, notably Australia (*2*).

Total profile thicknesses exceed 30 m (100 feet) in places. Crusts, although mainly thin (depths of 0.25 to 1.0 m are common), exhibit the familiar range of variation in texture, from loose nodules through slaggy forms to coherent quartzites and blocky silcrete (*2*, *3*). The mottled zones vary much in depth, some attaining 20 m, but usually the pallid zone constitutes the bulk of a given profile.

Ferruginized crusts range in color up to 7.5R 4/6, red on the Munsell scale; but thin-sectioning reveals that they consist primarily of sandstone, with the often hematitic iron coating the grains or filling the pore spaces. The silcrusts range from secondarily silicified arenites, wherein bedrock structures are perfectly preserved, to blocks identical in form, color, and texture with that of the gray billy of the Australian inland; silcrete blocks occur in association with highly reddened sandstone. The observed relationships recall those in part of the Australian transition zone between silcrusts and ferricrusts [see (*2*)].

The wide extent of the deeply weathered and duricrusted surface of southwestern Wisconsin implies pedogenesis under forest of the kind now called tropical in a climate probably belonging to the Aw type in Köppen's classification. We infer the affected surface to have been a pediplain (*4*, *5*), some of the divides on which are represented by the highest ground of today. No date can yet be offered for the last operation of deep weathering in the area. Parham has referred kaolinitic weathering in Minnesota to Cretaceous times (*6*), but the paleoclimate appears to have been suitable, where a land surface was exposed, as late as the mid-Miocene (*5*).

Of particular interest is the relation between deep-weathering profiles in the St. Peter sandstone and overlying dolomites of the Galena-Platteville succession: at the outcrop boundary, the profile passes under the dolomite, not infrequently becoming compressed. Since deep weathering and regional crusting imply a general lowering of the affected surface, but since the underground surface of the St. Peter sandstone displays no sign of having suffered erosion, we conclude that the profiles have not been buried; that is, where they occur underground, they are not relict from Ordovician times but have been developed in place, beneath tower karst in the former tropical conditions. On this basis, the pallid and mottled zones developed in the normal fashion, under the control of perennial and seasonally fluctuating groundwater, respectively, while the encrusting iron was precipitated near the top of the groundwater table during wet seasons. This conclusion is strengthened by the observation that the basal dolomite bed is commonly ferruginized from below. A further implication is that the former tower karst was, like its present-day Caribbean analogs, sufficiently permeable to swallow surface moisture.

G. H. DURY
Departments of Geography and Geology, University of Wisconsin, Madison 53706

J. C. KNOX
Department of Geography, University of Wisconsin

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Norepinephrine Stimulated Increase of Cyclic AMP Levels in Developing Mouse Brain Cell Cultures

Abstract. *Norepinephrine causes a four- to sixfold increase in the intracellular level of cyclic AMP (adenosine 3′,5′-monophosphate) reaggregated brain cell cultures derived from embryonic mouse brain. The cyclic AMP level of adult brain is increased by norepinephrine; however, embryonic mouse brain does not show a cyclic AMP response. The aggregate cultures thus demonstrate an event of differentiation very similar to that seen in vivo.*

Norepinephrine produces a fivefold increase in the level of cyclic AMP (adenosine 3′,5′-monophosphate) in slices of cerebral cortex of both rat and mouse (*1*). This stimulation of cyclic AMP levels is not observed in brains of newborn rats and appears only after 4 days of age (*2*). Thus, the response to norepinephrine can be considered to be a developmental event occurring during brain maturation.

Recently a brain cell culture system has been developed which shows patterns of biochemical differentiation similar to that of maturing mouse brain in vivo (*3*). This cell culture system is founded on the ability of dissociated cells to reassociate and to form aggregates during rotation culture (*4*). The brain cell aggregates are organized structures that often possess a cellular architecture resembling normal brain tissue (*5*). In addition, electron microscopic observations show the presence of highly developed synaptic regions in the aggregates after several weeks in culture (*6*).

Since the brain cell aggregates undergo several events of differentiation during culture, we determined their ability to develop a cyclic AMP response to norepinephrine. Isoproterenol was also used to test the β-adrenergic nature of the effector mechanism and to eliminate the possibility of inhibitory effects of α-adrenergic receptor stimulation on accumulation of cyclic AMP. The results are shown in Table 1. As expected, the fetal tissue does not respond to norepinephrine or isoproterenol. Although aggregate formation is essentially complete by 15 hours of culture, the catecholamines again fail to elicit an increase in levels of cyclic AMP in the cells. However, after 9 days of culture the aggregates show a four- to sixfold increase in cyclic AMP levels in response to both norepinephrine and isoproterenol—an effect of similar magnitude to that seen in adult mouse brain.

Other experiments (not shown) have indicated that the magnitude of the response does not change with longer culture times. In addition, when incubations were done in the absence of theophylline, the catecholamine-stimulated level of the cyclic nucleotide was not appreciably different from the levels presented in Table 1. In this respect the aggregate cell cultures also resemble slices of guinea pig and rabbit brain (*1*).

Clonal lines of rat glial tumors show large (> 200-fold) stimulatory effects of catecholamines on intracellular levels of cyclic AMP (*7*), suggesting that such response in normal brain and in the cultures described above may be due primarily to responding glial elements. Furthermore, primary monolayer cultures derived from embryonic rat brain show similar 50- to 100-fold stimulatory effects of catecholamines (*8*). Since considerable cell division takes place in the monolayer cultures, there is undoubtedly enrichment for glial cells, supporting the hypothesis that predominant cell type responding to norepinephrine in rat brain is glial.

The more "normal" magnitude of the response seen in the aggregates may be reflection of more natural proportions of neurons and glia present in these cultures. Presumably this is a consequence of the restriction of cellular division in a system where cell-cell interactions are prominent (*3*). The value of aggregate cell cultures is indicated by the fact that the development of norepinephrine responsiveness in these aggregates is the fifth phenomenon they have shown that is characteristic of the program of differentiation of the developing mouse brain. Others include increased specific activities of choline acetyltransferase, acetylcholinesterase, glutamate decarboxylase (*3*), and the formation of synapses (*6*).

Table 1. Effect of catecholamines on cyclic AMP levels of fetal mouse brain slices and brain cell aggregates. Brain cell aggregates and fetal tissue were preincubated for 30 minutes in Eagle's basal medium plus 0.4 percent glucose and $10^{-3}M$ theophylline at 37°C in an atmosphere of 5 percent CO_2 and 95 percent air. Norepinephrine and isoproterenol were added at a concentration of $10^{-4}M$ each and incubation was continued for 15 minutes. The medium was rapidly removed and the aggregates or tissue were homogenized in ice-cold 5 percent trichloroacetic acid. After centrifugation at 15,000*g* for 5 minutes, the supernatants were assayed for cyclic AMP content (*9*). The trichloroacetic acid precipitate was resuspended in 0.1*N* NaOH and assayed for protein (*10*).

Additions	Cyclic AMP (pmole/mg of protein)		
	Fetal tissue	Cell culture	
		15 hours	9 days
None	11	12	8.5
Norepinephrine	11	10	38
Isoproterenol	14	14	45

NICHOLAS W. SEEDS
Departments of Biophysics and Genetics and Psychiatry, University of Colorado Medical Center Denver 80220
ALFRED G. GILMAN*
Laboratory of Biochemical Genetics, National Heart and Lung Institute, Bethesda, Maryland 20014

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* Present address: Department of Pharmacology, University of Virginia School of Medicine, Charlottesville, 22903.

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