Table 1. Analytical data for potassium-argon age determinations; my, million years.

Sample	Material	Weight (g.)	K (%)	$Ar^{at}40$ (%)	$Ar^{r}40/K_{40}$	Age (my)
KA 1955, Two Teats quartz latite	Biotite	5.91	6.92	48	14.54×10^{-4}	$2.74 \pm .1$
KA 1956, Two Teats quartz latite	Plagioclase	15.98	0.80	75	14.30×10^{-4}	$2.70 \pm .1$

gone topographic reversal in the last 2.7×10^6 years. At least some of the quartz latite existed before the formation of the till at Deadman Pass, because the till incorporates locally-derived angular material similar to the lighter colored latite dated at 3.0×10^6 years. The presence of a lahar that appears to underlie the till 2 km north of Deadman Pass also suggests that the quartz latite existed before the formation of the till, because this volcanic mudflow deposit contains boulders of light-colored quartz latite in a matrix of ash and pumice.

The till that outcrops at Deadman Pass and is overlain by quartz latite under the hill immediately south of Deadman Pass is here termed the Deadman Pass till. The glaciation that deposited the till is termed the Deadman Pass glaciation. This glaciation occurred, probably as a series of multiple advances, between 3.1 and 2.7×10^6 years ago. The presence of latite in the till (similar to that dated at 3.0×10^6 years), the intimate association of the till with large quantities of ash and pumice, and the presence of the lahar under the till in one area all suggest that the Deadman Pass glaciation may have been penecontemporaneous with the extrusion of the darker quartz latite; if so, it may have occurred about $2.7 \pm 0.1 \times 10^6$ years ago.

The Deadman Pass glaciation is thus the earliest radiometrically established glaciation yet recognized in temperate latitudes. Its existence supports the suggestion by many Pleistocene vertebrate paleontologists that general climatic cooling in temperate latitudes began about the time of this glaciation (*4*). Other workers (*5*) have reported evidences of cooling or glaciation or both in polar areas, beginning within the period 2.5 to 3.0×10^6 years ago. Opdyke (*5*), through paleomagnetic analyses of deep-sea cores from the Bellingshausen Sea, showed that the first polar oceanic glaciofluvial detritus occurred shortly after the Mammoth geomagnetic polarity event. Work by Wensink (*5*) also suggested that the onset of glaciation in Iceland occurred just after the Mammoth event, about 3.0×10^6 years ago. The Deadman Pass deposits establish that glaciation on a global scale actually began shortly after the Mammoth event.

ROBERT R. CURRY
Department of Geology and Geophysics, University of California, Berkeley

References and Notes

1. N. K. Huber and C. D. Rinehart, *Geologic Map of the Devils Postpile Quadrangle, Sierra Nevada, California, GQ-437* (U.S. Geological Survey, 1965).
2. G. B. Dalrymple, *Univ. Calif. Publ. Geol. Sci.* **47**, 1 (1964). KA 1103=3.1=my andesite, KA 1135 = Two Teats quartz latite, KA 1167 = Mammoth Mountain quartz latite.
3. H. D. Erwin, *Calif. J. Mines Geol.* **30**, 7 (1934).
4. C. W. Hibbard, D. E. Ray, D. E. Savage, D. W. Taylor, J. E. Guilday, in *The Quaternary of the United States* (Princeton Univ. Press, Princeton, N.J., 1965), p. 509.
5. D. M. Hopkins, T. Einarsson, R. R. Doell, *Abstracts, INQUA, VII International Congress* (1965), p. 223; N. D. Opdyke, in press, H. Wensink, *Geol. Rundschau* **64**, 364 (1965).
6. Radiometric dating reported in Table 1 was supported by an NSF grant.

5 August 1966

Nebraskan and Kansan Stades: Complexity and Importance

Abstract. *Several Early Pleistocene stadial tills and related soils in Kansas and Nebraska indicate a complex history of ice-sheet fluctuations. It is impossible to assign ages to individual till sheets solely on the basis of position in a stratigraphic column; all Early Pleistocene correlations must be re-evaluated.*

A series of soils or weathering zones has been found within a complex alternation of Early Pleistocene glacial and nonglacial deposits in northeastern Kansas. This discovery, coupled with recognition of several Early Pleistocene till layers in eastern Nebraska, makes necessary a thorough restudy of all glacial deposits and associated sediments believed to have been formed during the first half of Pleistocene time.

Early acceptance of a generalized fourfold history of Pleistocene continental glaciation first led to adoption in field correlation of a kind of "numbers system." In the north central United States the highest till in a stratigraphic section was commonly correlated with the Wisconsin glaciation; the first underlying till, with the Illinoian (or sometimes Iowan) advance; and so on. There developed, however, gradual recognition of evidence of a complex sequence of retreats and minor readvances of the generally waning ice sheet, and of the occurrence of nonsynchronous maxima of separate though adjacent lobes. This knowledge caused abandonment of such a simple approach to the chronology of, first, the Wisconsin and, later, the Illinoian stage, and criteria were sought to permit positive identification of single stratigraphic units without reference to the entire section, often incomplete, in which they occurred.

In the contiguous parts of Nebraska, Kansas, Missouri, and southern Iowa that were subjected to glaciation only in Early Pleistocene time, the "numbers system" has continued in use: if two tills are present in a given exposure, the upper one is automatically considered to be of Kansan age; the lower one, of Nebraskan. Thus the presumption has continued that Early Pleistocene glaciations were each comprised of a simple advance and retreat that deposited only a single layer of till, even though it is well known that the later glaciations were not as simple as that. However, recent discoveries clearly indicate that the Early Pleistocene glacial episodes were just as complex as those that followed.

The Early Pleistocene record in Nebraska is at present interpreted (*1*) as indicating two stadial advances of the continental glacier during Nebraskan time and three stadial advances during Kansan time. Each of these advances is represented by a till body, and retreatal episodes are marked by the development of soils and erosion surfaces. This proposed sequence in Nebraska is composite, resulting from interpretive correlation of surface and subsurface data from a number of localities; the evidence is not found in any one section.

The earlier Nebraskan (Elk Creek) till (*1*) rests on proglacial (David City) sand and gravel; its upper surface is considerably eroded. The later Nebraskan (Iowa Point) till is dated on the basis of its position above silt (Seward) believed to be the periglacial equivalent of the earlier Nebraskan till.

Overlying a well-developed Aftonian interglacial soil, commonly dark gray

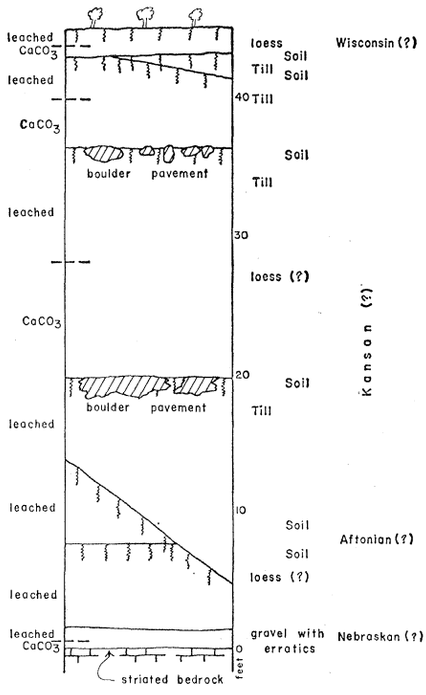

Fig. 1. Diagrammatic columnar section of glacial deposits and weathering zones exposed in a quarry near Doniphan, Kansas. Hatched areas are boulders and masses of shattered, transported rock from nearby sources.

or black in areas that were poorly drained, is the early Kansan (Nickerson) till. This is said to be the most extensive of the till sheets present in Nebraska and Kansas. Its upper surface locally shows development of a thin soil (Fontanelle), which is in turn overlaid in some localities by the medial Kansan (Cedar Bluffs) till, which is deeply oxidized in its upper part. The upper Kansan (Clarkson) till, previously considered to be of early Illinoian age, is present only in northeastern Nebraska.

The record of stadial subdivisions of Early Pleistocene glaciations in Kansas (*2*) is more complex than that now recognized in Nebraska. It is also more precise in that the data come from a single, truly remarkable exposure, thereby escaping some of the inevitable doubts that accompany interpretive correlation of separate parts from several different localities.

In a single vertical section 13.7 m high and 33.5 m wide at one end of an abandoned quarry near Doniphan, 8 km north of Atchison, Kansas (Fig. 1), there is exposed a sequence of four tills plus one gravel that contains erratic rock fragments. Separating these stratigraphic units, and indicating episodes of nonglacial conditions, are six buried soils or weathering zones, readily recognizable by horizonation and color changes, as well as by alternations of carbonate-rich and carbonate-free (leached) zones. At the base of the section the erratic fragment–bearing gravel rests on a striated bedrock surface. Both the excellence of the exposure and clear contrasts in physical and chemical characteristics of the various horizons preclude confusion of slump blocks with true stratigraphic sequence.

Assignment of age designations to the five glacial members of this section is impossible by a numbers system admitting of only two glaciations that affected northeastern Kansas. A relatively thick, dark-gray, well-developed soil below the lowest till is believed to be the Aftonian soil. If this speculative correlation is correct, the Nebraskan glaciation is represented in this locality only by the striated bedrock surface and the very sparse scattering of fragments of igneous and metamorphic rock in the overlying gravel. The four tills and interbedded nonglacial sediments, together with the weathering zones, above the Aftonian(?) horizon would then be the result of four stadial advances of the Kansan glacier.

Of greatest significance in these discoveries is the clear demonstration of complexity in the Early Pleistocene glacial record and the present absence of recognized criteria that indicate with certainty the age of individual Early Pleistocene till bodies. If two tills are present in a single exposure, the upper is not necessarily of Kansan age, the lower not necessarily of Nebraskan. A series of till sheets resulting from stadial fluctuations may occur in unusually well-preserved deposits from either glaciation. Therefore all assignments of Nebraskan or Kansan ages, or of both, to bodies of glacial, proglacial, or periglacial sediments must be reexamined in the context of multiple stades.

A corollary is that any fossils and any geologic or climatic events that have been assigned ages based solely on association with an Early Pleistocene till also must be restudied within the complex framework that current field investigations are revealing. Furthermore, the problem affects not only areas in which Early Pleistocene sediments are exposed at the surface, but also areas of subsurface occurrences beneath younger Pleistocene deposits.

WAKEFIELD DORT, JR.
Department of Geology,
University of Kansas, Lawrence

References and Notes

1. E. C. Reed and V. H. Dreezen, *Nebraska Geol. Surv. Bull. 23* (1965); E. C. Reed *et al.*, in *The Quaternary of the United States*, H. E. Wright and D. Frey, Eds. (Princeton Univ. Press, Princeton, N.J., 1965), pp. 187–202.
2. W. Dort, Jr., *Abstr. Geol. Soc. Amer. Ann. Mtg. 1965*, p. 46; in preparation.
3. Work aided by the State Geological Survey of Kansas and by the University of Kansas General Research Fund.

2 September 1966

Staphylococcal Alpha-Toxin: Effects on Artificial Lipid Spherules

Abstract. *Staphylococcal alpha-toxin induces the release of previously sequestered anions or glucose from artificial phospholipid spherules, an effect abolished by specific antitoxin. Alpha-toxin resembles streptolysin S in releasing anions or glucose from spherules prepared without cholesterol, and can be distinguished from the membrane-active polyene amphotericin B, which preferentially disrupts spherules containing cholesterol. It may affect biological structures by a similiar interaction with membrane phospholipids.*

Staphylococcal α-toxin, a protein of approximately 44,000 molecular weight, can be isolated in relative purity from culture filtrates; it induces hemolysis in vitro, causes necrosis of skin in vivo, and is lethal to small laboratory animals (*1*). It also disrupts platelets and lysosomes in vitro and is cytotoxic for cultured mammalian cells (*2*).

These effects have been attributed to a primary action of the toxin upon membranes which bound cells, their organelles, or both (*1, 3*). However, the identity of the component of the membranes of cells or their organelles with which the toxin reacts has not been established. Streptolysin S, an analogous bacterial exotoxin, destroys lysosomes and erythrocytes by virtue of its capacity to disrupt their limiting membranes, and it promotes changes in the gross permeability to ions, glucose, and glycine of artificial phospholipid-cholesterol spherules by disrupting their lamellar substructure (*4*). Streptolysin S produces these effects by an interaction with lecithin, or with long-chain polar lipids, rather than with membrane sterols. Its behavior was opposite to that of amphotericin B (a polyene antibiotic), which preferentially disrupted natural or artificial lipid structures containing sterols (*5*).