

spectrum of Pfl. Tryptophan is distinguished in fd by its Raman lines at 757, 878, 1012, 1362, and 1560 cm^{-1} , while proline and glutamic acid account for the lines of fd at 415 and 670 cm^{-1} . Conversely, the lines of Pfl at 405, 444, 520, 655, and 945 cm^{-1} may be attributed to glutamine and arginine residues. As in the case of R17 phage (8), the CH-stretching (2800 to 3100 cm^{-1}) and CH-deformation (1320 to 1460 cm^{-1}) regions are dominated by contributions from the -CH, -CH₂, and -CH₃ groups of amino acid side chains (17).

In summary, the Raman data indicate the following features of FB virus structure. The coat proteins of Pfl and fd virions have the same α -helical secondary structures. The α -helices undergo a reversible change in geometry over the temperature interval 32° to 75°C. At the higher temperatures in this range, α -helices are maintained but apparently with somewhat weaker intramolecular hydrogen bonding than occurs at lower temperatures. The DNA chain in the virion of Pfl or fd maintains a configuration in which the local geometry of phosphodiester linkages is dissimilar to that found in A-DNA. The DNA bases are probably stacked but no information on base pairing has been obtained from the spectra. These features of viral DNA structure are not altered over the range 32° to 75°C.

The significant spectral differences between Pfl and fd are due to the different amino acid compositions of their respective coat proteins. The Raman spectrum therefore provides a simple and straightforward means of detecting and distinguishing these closely related FB viruses.

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14. We estimate that no more than 5 percent of the amino acid residues could exist in β regions without generating both a shoulder to the observed amide I line near 1665 cm^{-1} and a line in the amide III region near 1235 cm^{-1} . A nominally higher percentage of residues in randomly oriented regions would be allowed by our data.
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17. A complete list of the observed Raman frequencies and assignments of Pfl and fd is available on request.

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Denudation Studies: Can We Assume Stream Steady State?

Abstract. *Contemporary stream sediment loads are dubious indicators of regional denudation. Recent analysis of ten river basins in the southeastern United States indicates that of the material eroded from upland slopes since European settlement, only about 5 percent has been exported. The remainder, alluvium and colluvium, will probably not be exported because of extensive reservoir impoundments.*

Stream steady state, wherein the solid material transported from stream basins is considered approximately equal to that eroded from upland slopes, cannot be assumed for much of the United States since European settlement (1). Sediment from culturally accelerated erosion has so over-loaded streams that most of it has been deposited within the system. Thus, stream sediment loads, as used in most denudation studies (2, 3), are questionable indicators of regional denudation.

Analysis of ten large river basins, mostly within the southern Piedmont, indicates

that of the material eroded from upland slopes since European settlement, only about 5 percent has been exported. Gross erosion (detached materials) was estimated from soil profile truncations (4), and sediment yields (export) were estimated from U.S. Geological Survey data (5) on suspended stream load with adjustments for bed load. Because of the varying length of agricultural occupancy of the basins, gross erosion and sediment yields were converted to standardized rates (Fig. 1); areally weighted, they average 95 and 4.5 mm per 100 years, respectively. Delivery

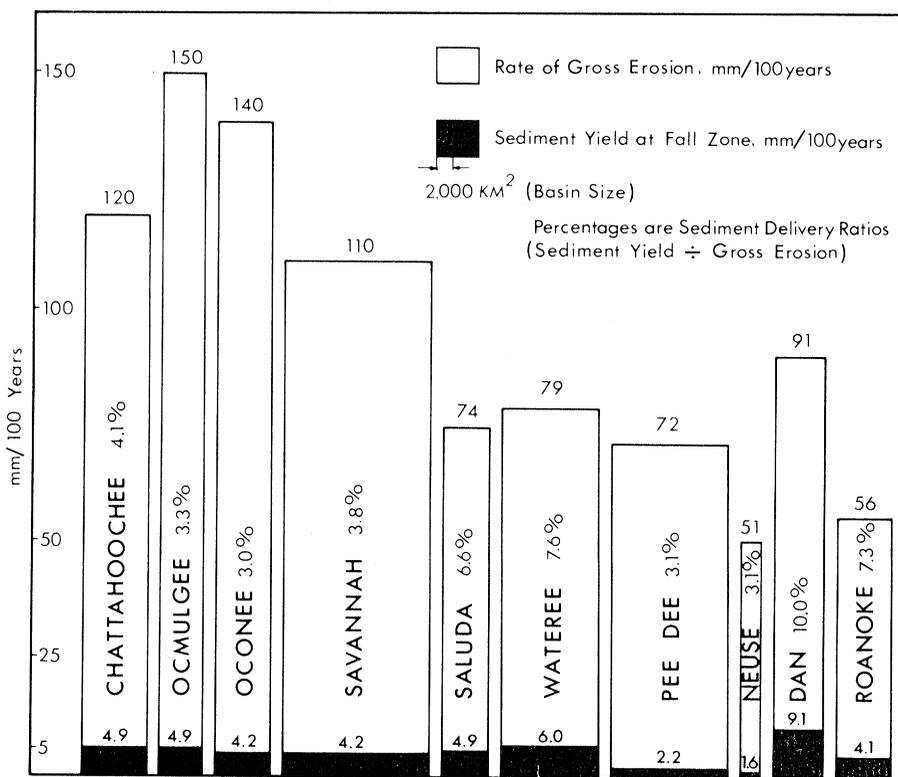


Fig. 1. Gross erosion (detached material), sediment yields (exported from basin), and sediment delivery ratios of selected southern Piedmont river basins since agricultural occupancy began. The areally weighted averages are: gross erosion, 95 mm per 100 years; sediment yield, 4.5 mm per 100 years; sediment delivery ratio, 4.7 percent.

ratios (sediment yield as a proportion of gross erosion) range from about 3 to 10 percent, with a weighted average of 4.7 percent (Fig. 1), a figure consistent with the results of a previous study (6).

The eroded material not transported from the basins has been deposited as colluvium and alluvium, with the alluvium as deep as 6 m in second to fifth order (small to medium-sized) streams (7). The formation of such deposits indicates a definite lack of the steady state. At present, as a result of declining agricultural land use and generally implemented soil conservation practices, streams have regained their transport ability, and the modern alluvial deposits in some are being dissected. That is, oversteepened gradients are readjusting and alluvium is migrating. However, this movement is limited by many large reservoirs, which act as efficient sediment traps. Thus, the sediment will not be exported within the foreseeable future (8).

By inference and according to the available evidence, many streams of the humid United States are analogous to those of the Piedmont and thus have not been in a

steady state since European settlement. This means that "denudation rates" determined from downstream sediment yields are not synonymous with rates of erosion or with lowering of the land, as has frequently been assumed (3, 9).

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Weyl's Theory of Glaciation Supported by Isotopic Study of Norwegian Core K 11

Abstract. *Oxygen-18 analyses of pelagic and benthic foraminifera from core K 11 indicate that during the last glaciation Norwegian Sea bottom waters were warmer than in modern times and had the same physical parameters (temperature, oxygen isotope ratio, and salinity) as the North Atlantic deep water. This result indicates that the glacial Norwegian Sea was not a sink for dense surface water, as it is now, and that during glacial times North Atlantic deep water invaded the deep Norwegian basin.*

Oxygen isotopic analyses provide information about past ice-cap volumes and sea temperatures. The isotopic records of cores from the Atlantic (1), Pacific (2, 3), and Indian (4) oceans are highly correlated and have provided information about the worldwide evolution of oceanic climate. Numerous attempts have been made to correlate Pleistocene climatic cycles with variations in insolation calculated by Milankovitch (5), but thermodynamic calculations indicate that such variations may have been too small to trigger glacial climates (6). A possible mechanism for glaciation has been suggested by Weyl (7), who showed that minor long-term changes in the average behavior of the atmosphere might have triggered a decrease of the surface salinity of the North Atlantic, allowing sea ice to extend as far south as it does in the Pacific, that is, to almost 60°N. Such a southward extension of sea ice would have cooled northern Europe to temperatures similar to those of Alaska at present. The Norwegian Sea provides a

striking test of Weyl's hypothesis. That sea is today a typical mediterranean basin (8) in which an inflow of light surface water is required to balance the outflow of deep, dense water formed by the action of the atmosphere at the sea surface within the basin. In a glacial period, according to Weyl's theory, the formation and sinking of dense water in the Norwegian Sea would have been suppressed. Newell (9) has related climatic fluctuations to coupling of the oceans and the atmosphere and suggested that the glacial periods resulted from variations in the poleward energy flux in the ocean-atmosphere system. Newell's theory also implies that the glacial Norwegian Sea was not a sink for dense, cold surface water. Ice ages are thus considered as periods of warming of the ocean.

During the cruise NESTLANTE I of the French R.V. *Jean Charcot* in the Norwegian Sea (August 1970), piston core K 11 was collected at 71°47'N, 01°36'E, from a water depth of 2900 m.

We analyzed $\delta^{18}\text{O}$ (10) for the pelagic species *Globigerina pachyderma* and the benthic species *Pyrgo depressa*, *Pyrgo oblonga*, and *Planulina wuellerstorfi* from core K 11. The experimental method has been described by Shackleton (11). A Micromass 602 C mass spectrometer was used. Each sample weight was about 0.4 mg of carbonate. Replicate analyses of the same carbonate give a standard deviation of 0.13 per mil for a single measurement. Pelagic samples were analyzed in triplicate, so that the precision of the mean is ± 0.07 per mil. Benthic specimens were much scarcer and generally were analyzed only once or twice.

The two species of *Pyrgo* give results indistinguishable from each other. *Planulina* has been already reported as isotopically lighter (2, 12). For core K 11, the mean difference in $\delta^{18}\text{O}$ values between *Planulina* and *Pyrgo*, deduced from a comparison of 25 levels in the core, was 1.15 ± 0.03 per mil. In obtaining mean values for each level in the core, we added 1.15 per mil to the *Planulina* values to correct for this effect. The $\delta^{18}\text{O}$ values for *Globigerina pachyderma* and the benthic species are shown in Fig. 1A. It was possible to correlate the *G. pachyderma* curve with stages 1 to 6 defined by Emiliani (13), which indicates that the sediment was not reworked. The benthic curve shows only minor variations all along the core and significant scattering (14). To suppress the scatter in the benthic curve, we smoothed the curve by calculating the running mean, using three adjacent samples for each level (15).

Figure 1B compares benthic curves obtained from Norwegian core K 11 and Pacific core V 28-238 (2, 3). From stage 1 to stage 2, benthic foraminifera become richer in ^{18}O in both cores, but the enrichment in the Norwegian core is much smaller (0.4 per mil) than that in the Pacific core (1.5 per mil). At the beginning of stage 3, the variations in both curves are well correlated and probably reflect minor variations in seawater ^{18}O . The small amplitude of the variations in the Norwegian benthic curve and the difference between the Norwegian and Pacific benthic curves can be explained in terms of bottom water temperatures.

The measured present temperature of the bottom water just above the site of core K 11 is -0.9°C ; the water could not have been much colder, even in a glacial period. Hence, the temperature of the bottom water of the Norwegian Sea must have been either the same as at present, or warmer.

We first assume that the Norwegian Sea bottom water temperature has remained constant. Then, since the $^{18}\text{O}/^{16}\text{O}$ ratio of the benthic foraminifera depends on the temperature and on the $^{18}\text{O}/^{16}\text{O}$ ratio of