Reports

Overbank Sedimentation in the Delaware River Valley during the Last 6000 Years

Abstract. *A thick sequence of floodplain sediments has accumulated in the Delaware River Valley by the process of overbank deposition. Textures in the sediments indicate that the sequence contains no point-bar deposits and is unbroken by periods of erosion. Fourteen radiocarbon dates show that deposition began at least 6000 years ago and has continued to the present. Because the Delaware River shifts its position laterally at a very slow rate, overbank deposition becomes dominant in the construction of its floodplain.*

During the summers of 1964 through 1968, 1970, and 1972 a series of 62 archeological sites situated on the Pennsylvania side of the Upper Delaware Valley between the Delaware Water Gap and Port Jervis, New York, were surveyed, mapped, and evaluated. Excavations were made at 11 of these prehistoric American Indian camp and village sites under the auspices of the North Museum, Franklin and Marshall College (*1*). This work was extensively supported by the National Park Service, U.S. Department of the Interior, as part of its program to salvage important archeological, paleontological, and historical information before construction of the proposed Tocks Island Reservoir could destroy these resources.

The most important excavations were conducted at the Faucett site which is located 2.9 miles (4.7 km) north of the village of Bushkill, Pennsylvania. The site consisted of approximately 60,000 square feet (5574 m^2) of excavations, located only 60 feet (18 m) from the channel of the Delaware River. Investigations revealed at least 12 different occupations or cultures in stratigraphic sequence beginning about 6000 years ago.

Table 1. Radiocarbon dates at the Faucett site.

Depth (cm)	Age (years before the present)	Component
Pit	558 ± 100*	Tribal
Pit	658 ± 120*	Owasco
30	1178 ± 120*	Kipp Island
46–62	2068 ± 135*	Bushkill
46–62	2370 ± 95†	Bushkill
76	2718 ± 100*	Meadowood
46–62	2778 ± 100*	Orient
145	3468 ± 120*	Perkiomen
152–168	4580 ± 110†	Lackawaxen
175–185	4150 ± 180†	Lackawaxen
168–183	4465 ± 130†	Lackawaxen
183–198	5198 ± 200*	Brewerton
198–213	5590 ± 200†	Vosburg
244–259	6190 ± 135†	Unknown

* 1968. † 1970.

Geologically, the Delaware Valley here is set in a thick sequence of intensely folded, Paleozoic sedimentary rocks (*2*), and the position of the river is controlled by and generally follows their regional northeast strike. Near the Faucett site the valley was filled with Late Wisconsinan outwash gravel (*3*), now preserved as broad terraces which occupy a major portion of the valley bottom. Silts and fine sands overlie the glaciofluvial gravel and form the surface of the youngest and lowest terrace in the valley, approximately 25 feet above the low water level. The excavations at the Faucett site were conducted in these deposits.

Fourteen radiocarbon dates (*4*) from the various cultural deposits have been used to outline the cultural-chronological sequence. The dates, obtained from charcoal found in subsurface hearths and living surfaces, and the identifications of the various cultural components, are presented in Table 1. Data on the rate of overbank accretion are presented in Table 2. The two most recent dates are not pertinent to problems of overbank accretion since they were associated with aboriginal storage pits that were dug into the subsoil. Although these recent dates are valid, they do not represent horizontal living surfaces. Plus and minus factors with respect to laboratory errors were not considered, but we recognize that they could alter our interpretations of the rate of deposition. Vertical measurements of sediment accumulation between each pair of dates were taken from the midpoint within each 6-inch (15.2-cm) excavation level. Mean ages and mean levels were used where there are two or more dates or levels for the same occupation or component.

In addition to its archeological value, the Faucett sequence provides much needed information concerning the general understanding of floodplains and their origins. The processes and rates of floodplain development have been determined in many different localities by numerous workers using varied methods (*5*–*9*). Most students of floodplains agree that two processes, functioning simultaneously, are usually responsible for construction of the feature. One process, caused by the sideways migration of the river channel, results in a layer of laterally accreted, point-bar sediment being spread more or less evenly across the valley bottom. The second process occurs when periodic floods overtop the channel banks and deposit vertically accreted, overbank sediment. Normally, the overbank deposits are rather thin since the rate at which rivers migrate across their valley bottoms is commonly rapid enough to rework all the valley-floor sediments before thick accumulations of overbank material can develop. In addition, each successive increment of overbank sediment should require more time for its accumulation than the one before it because floods of greater magnitude are needed to exceed the confines of the channel as the floodplain grows progressively higher. It follows, therefore, that some studies estimating the rate of overbank deposition have been based on relatively short time spans (*6*, *9*). Furthermore, those studies encompassing longer periods are often derived from a small number of dates or involve a complex alluvial history and thus lack detail concerning the continuum of deposition (*7*, *8*). It is not odd, then, that the valley-bottom

Table 2. Corresponding rates of overbank accretion.

Interval	Rate of accretion (cm/year)
Unknown to Vosburg	0.077
Vosburg to Brewerton	.039
Brewerton to Lackawaxen (mean)	.029
Lackawaxen (mean) to Perkiomen	.025
Perkiomen to Orient-Meadowood	.115
Orient-Meadowood to Bushkill	.014
Bushkill to Kipp Island	.022

mechanics as described above have prompted the suggestion that overbank sedimentation is of only minor importance in the development of a floodplain (*7*). The data from the Faucett site allow us to detail a record of continuous overbank accretion for a long time period and also to demonstrate that, in the absence of lateral migration, overbank deposition is a very significant process, an observation which supports a similar conclusion made earlier by Schumm and Lichty (*9*). Since the floodplain level of most streams is equaled or exceeded once every 1 or 2 years (*7*), the Faucett site deposits are not technically part of the modern floodplain. However, even though the surface of the site is well above the floodplain stage, it is still periodically flooded (*10*) and the sediments continue to increase in elevation and thickness. Their designation as deposits capping a Pleistocene terrace does not alter the fact that they are part of a dynamic geomorphic feature which differs from a true floodplain only by definition, not process of origin.

We believe that the Faucett site sequence is devoid of point-bar sediment for several reasons. First, the variability in grain size and sorting commonly noted in point-bar deposits (*7*) is absent in this sequence. Size analyses of seven samples taken at regular depth intervals in the main excavation of 1970 show that the Faucett sediments are very consistent in size and sorting. Median grain sizes range from 0.09 to 0.14 mm, and sorting coefficients vary from 1.55 to 1.82. Second, the evidence of abundant scour and fill, normal in point-bar deposits, has not been observed at the Faucett site. Finally, the continuity of the 14 radiocarbon dates strongly supports the suggestion that deposition here has not been periodically interrupted by episodes of scouring.

If the characteristics described above portray a continuous accumulation of overbank sediments, it becomes clear that the Delaware River has maintained its present valley-bottom position for an extremely long time. Measured rates of lateral migration of rivers usually range from 0 to 2000 feet per year (0 to 600 m per year) (*7*). Even at a low rate of only 0.5 foot per year, the Delaware River should have been able to traverse its valley (3000 feet wide) during the 6000-year record of the Faucett site accumulation. Had it done so, the older sediments would have been disturbed and the earlier records of human occupation rendered unintelligible. Thus, the Faucett sequence demonstrates that a natural channel in unconsolidated material can be fixed for very long periods of time and that under those conditions overbank accretion becomes the dominant process involved in the development of the floodplain.

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Magnetic Transitions Observed in Sulfide Minerals at Elevated Pressures and Their Geophysical Significance

Abstract. *The magnetic behavior of iron in chalcopyrite ($CuFeS_2$) and pyrrhotite (Fe_7S_8) in the pressure range from 1 atmosphere to 20 kilobars has been studied by Mössbauer spectroscopy. Both chalcopyrite and pyrrhotite exhibit transitions from magnetically ordered to disordered states over the range from 5 to 16 kilobars. Both transitions, particularly the loss of ferrimagnetism in pyrrhotite, have geophysical consequences.*

Kasper and Drickamer (*1*) have demonstrated by Mössbauer spectroscopy that the antiferromagnetic ordering of FeS (troilite disappears before a pressure of 36 kb is attained. We have obtained Mössbauer spectra at high pressures on the related ferrimagnetic iron sulfide pyrrhotite (Fe_7S_8) and the antiferromagnetic sulfide chalcopyrite ($CuFeS_2$). The results, which are reported here, show that similar reversible magnetic transitions from ordered to disordered states occur in both chalcopyrite and pyrrhotite in the range from 1 atm to 20 kb. The results for troilite (FeS), chalcopyrite, and pyrrhotite have important implications for solid-state theory and the chemistry of the interiors of the earth and other planetary bodies. The pyrrhotite result, in particular, has geomagnetic and paleomagnetic consequences.

Data are reported here for $CuFeS_2$ and Fe_7S_8 synthesized from pure elements in sealed, evacuated silica-glass tubes according to the method of Kullerud (*2*). The iron used in the synthesis contained > 90 percent of the Mössbauer active isotope ^{57}Fe, and all of the elements used were 99.99+ percent pure. Separate samples of both the iron and the copper were reduced in a stream of pure dry hydrogen at 700°C. After the mixtures had been sealed in the silica-glass tubes they were reacted at 700°C, and the products were reground and annealed at 250°C. The purity of the synthetic products was verified optically and by x-ray diffraction.

Mössbauer spectra were first obtained from the powdered synthetic chalcopyrite and pyrrhotite, each mounted as a thin disk of material as is customary in experiments at room temperature and 1 atm. These spectra are illustrated in Figs. 1A and 2A and closely resemble spectra previously obtained, respectively, from both natural and synthetic chalcopyrite and pyrrhotite (*3–5*). The spectrum of powdered chalcopyrite at 1 atm (Fig. 1A) consists of a single six-peak hyperfine magnetic spectrum and has been interpreted as due to the presence of high-spin Fe^{3+} in the tetrahedral sites of the sphalerite-type structure of chalcopyrite. These ferric ions are antiferromagnetically ordered