weight-loss, i.e., a derivative curve, is also presented. The derivative curve is more dramatic and facilitates comparison of samples. However, the TGA software varies the Y-axis scale depending on the derivative range, and hence the amplitude of the derivative curve is not always directly comparable from sample to sample. To compare the amount of weight loss between samples, the weight-loss percentage curve is best. Both curves are displayed together for each sample in Appendix C.

All sediment samples had very small weight losses between temperatures of 70°C to 550°C (representing oxidation of organic matter), and all but a few also had small weight losses between temperatures of 550°C to 1000°C (representing oxidation of carbonates) (Figure 6; Table 3; Appendix C). Fortunately, several samples have distinct and comparable derivative weight-loss curves providing a means for correlating sediments between the skeleton and the site.

Skeleton Sediments

Four of the sediment samples taken from the skeleton have relatively low amounts of organic matter (between 1.2% and 1.8%)(Table 3). Such levels of organic matter are commonly found in fine textured alluvial sediments due to incorporation of detrital organic matter (Stein 1992). However, there are possible alternative sources for the organic matter including modern rootlets such as were observed on many bones and in the adhering sediment, and/or soluble organic acids produced in the modern surface soil and leached downward or residual in buried A horizons. The dark-colored sediment removed from the pelvis has the highest measured organic matter content (2.3%). It also has a derivative curve of weight loss that displays a distinctive shape, different from the other skeletal samples. The shape displays three small dips between temperature 70°C and 550°C. The first dip probably represents the weight loss from evaporating water held in the lattice structure of clays and organic matter; the second and third dips represent the oxidation of organic matter. Higher organic matter content is also supported by the relatively dark color of the sediment. This suggests that the dark sediment may have originated from a layer close to the modern A horizon or alternatively from the modern shore sediments.

Weight loss due to oxidation of carbonates is more varied and dramatic than that for organic matter. The loss-on-ignition results for the concretion (97.I.25c) indicate a very large weight loss after 550°C, suggesting that the concretion is half carbonate by weight (Table 3). The metatarsal sediment (97.L.24[Mta&Mtb]) contains intermediate amounts of carbonate (18.5%), as does the sediment from the marrow cavity of the femur (97.R.18a)(18.4%). These intermediate values indicate that carbonate is present but not concentrated into a nodule or concretion, and explain why the sediment, although not completely indurated with carbonate, may have remained with the bone even after exposure to the swash and backwash of shallow waters of Lake Wallula. Sediment in the cranium (97.U.1a) has only 6.7% carbonate, which explains why it was softer and more easily extracted. Micromorphological examination indicates that the sediment within the cranium contains partially leached secondary calcite (Appendix B). Given that there is less carbonate in the cranium sediments than in sediment adhering to other bones, the sediment inside the cranium may have been protected from carbonate illuviation, i.e., percolation of calcite-enriched waters was impeded by the cranium and limited to a few openings in the skull. The least amount of carbonate from any sediment extracted from the skeleton was measured in the dark sediments on the pelvis (3.7%) suggesting that it may have originated from closer to the modern surface, or more likely, from the shore of Lake Wallula.

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Site Sediments

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Organic matter content decreases with depth in the upper 90 cm of CPP054 (Table 3); this includes all of Lithostratigraphic Unit I and the upper 20 cm of Lithostratigraphic Unit II. The highest value of organic matter (2.2%) is found in the modern A horizon near the surface at 10-20 cm, the upper part of Lithostratigraphic I (Wakeley et al.'s Stratum I). The next highest values are 2.1% and 1.7% and found in samples from 30-40 cm and 50-60 cm representing the middle part of Lithostratigraphic Unit I (Wakeley et al.'s Stratum II or III). Organic matter content ranges 1.4% to 1.8% in the upper part of Lithostratigraphic Unit II (Wakeley et al.'s Stratum IV) within the concretion-bearing stratum. The lowest organic matter content (1.0%) is from a calcitic concretion at 80-90 cm and reflects more of the diluting effect of calcite rather than a real drop in organic matter content at that depth. Two samples from below the concretion-bearing stratum (Wakeley et al.'s Stratum V) have comparable organic matter values of 1.6 and 1.7%. All of these values are reasonable for fine-textured alluvium affected by pedogenesis and comparable to sediments adhering to the skeleton.

The weight-loss derivative curves for samples from the upper part of the profile show two marked increases in slope in the temperature range of 450° to 550°C. The first increase probably represents the weight loss from evaporating water held in the lattice structure of clays and organic matter; the second increase represents the oxidation of organic matter, but a kind of organic matter different from that observed in the derivative curve for dark sediment from the pelvis. This second peak is not evident in the sample from 50-60 cm, nor in the samples from 70-80 cm, 80-90 cm, or 0-10 cm (core). There is a slight expression of this second peak in the sediment sample from CPP054, 95-135 cm. The curves for the two samples from Lithostratigraphic II located lower in the profile at depths of 30-40 cm and 60-66 cm in CPC059.5 (Wakeley et al.'s Stratum V) are slightly different from all other site samples. These curves have a dramatic peak representing the weight loss from evaporating water held in the lattice structure of clays and organic matter, with a less dramatic peak for the oxidation of organic matter. As mentioned before, the scale of the derivative curve varies for each sample, yet the overall shapes of the curves can be compared. Accordingly, these lowermost thermogravimetric samples are unique and contrast with sediments higher up in the profile, thus supporting Wakeley et al.'s separate stratum designation (Stratum V). In sum, the thermogravimetric curves indicate that although the amount of organic matter and carbonate varies between samples, the kind of organic matter and mineralogy present is similar in samples above 135 cm depth which includes all of Lithostratigraphic Unit I and the upper part of Lithostratigraphic Unit II (Wakeley et al.'s Strata I, II/III, and IV) but different for samples below 135 cm depth (middle and lower part of Lithostratigraphic Unit II and Wakeley et al.'s Stratum V).

Carbonate values for site sediment samples range widely with depth (Table 3; Figure 6), although there is a gradual increase with depth above 90 cm depth. The lowest carbonate value (2.8%) is found in the modern A horizon near the surface at 10-20 cm, the upper part of Lithostratigraphic I (Wakeley et al.'s Stratum I). This increases to approximately 8.7% at 70-80 cm depth. Carbonate values for the concretion-bearing stratum are highest in the sequence, but are exaggerated by the fact that for sample CPP054, 80-90 cm one concretions indurated with carbonate was selected for individual analysis and not surprisingly yielded carbonate contents close to 50%. This concretion was selected as a comparison for the concretion extracted from the skeleton. Carbonate values for samples from 70-80 cm (8.7%) and 95-135 cm (5.0%) better represent the range of values for sediments surrounding the concretions. The sediment sample taken from CPC059.5, 0-10 cm must have contained a small concretion given its carbonate content of 35.0%. Thus, the concretion-bearing stratum (upper part of Lithostratigraphic Unit II or Wakeley et al.'s Stratum IV) seems to contain a large amount of carbonate, but it is concentrated into concretions that are not easily measured in sample sizes as small as dictated by TGA (.07 grams). Finally, carbonate content for the two deepest samples (Wakeley et al.'s Stratum V) contain the lowest amounts of carbonate of all of the samples (1.8%) and appear to have experienced either little calcification or have been effectively decalcified.

Changes in the rate of weight loss at temperatures between 600°C and 800°C produced a distinctive peak in the derivative curve for samples in Lithostratigraphic Unit I and the upper part of Lithostratigraphic Unit II. This suggests that although the amount of carbonate varies between these samples, the kind and form of carbonate seems to be similar. Again, however, the samples from Wakeley et al.'s Stratum V are different with the same peak being less distinct and occurring closer to the 600°C temperature. Hence, Stratum V appears unique in both its carbonate and organic matter assemblage.

One other moderately defined trend is evident in the thermogravimetric data. The temperature corresponding to the peak of the derivative curve, i.e., the maximum rate of weight-loss, for sediment samples from the site generally increases with depth, at least within approximately the upper one meter of the terrace. Because these temperatures are greater than 600° C, we believe they relate to the carbonate content in the sediment, although it is uncertain if this represents differences in carbonate chemistry or crystal size.

Comparison of Skeleton and Site Sediments

Some distinctive comparisons can be made between the sediment extracted from the skeleton and site. First, the organic matter and carbonate contents of the concretions extracted from the skeleton (97.I.25c) and the sample located in the upper part of Lithostratigraphic Unit II (CPP054, 80-90 cm) are almost identical with respect to their TGA curves. This suggests that the concretion on the skeleton was formed when the human remains were within the upper part of Lithostratigraphic Unit II. The skeleton could, however, have come from any depth within the concretion-bearing stratum, i.e., the upper part of Lithostratigraphic Unit II above Wakeley et al.'s Stratum V.

Second, the other four sediment samples extracted from the skeleton are comparable to each other and to two site samples (CPP054, 80-90 cm and CPC059.5, 0-10 cm). in terms of carbonate content. This suggests that the sediment adhering to the human remains is only that sediment with the highest levels of carbonate. In other words, the carbonate is one of the reasons that the sediment is still adhering to the skeleton. Without the carbonate holding the sediment to the bone, the sediment would have washed away in the waters of Lake Wallula.

Third, the dark sediment from the skeleton (97A.I.17a; os coxsae) is dark because it contains higher levels of organic matter, levels comparable to the A horizon of the modern surface soil. Its TGA derivative curve, however, has a distinctive third peak suggesting that the sample has an additional kind of clay mineral or organic matter not present in the A horizon. We believe the dark sediment most likely became attached to the bones while they were laying in the shallow shorezone of Lake Wallula.

Finally, the samples extracted from the skeleton (other than the dark sediments) have no organic matter signature in the TGA curve data. This suggests that the weight loss recorded up to 550°C was not the result of organic matter oxidation. It was more likely related to the weight loss from evaporating water held in the lattice structure of clays. This suggests that the skeleton was located well below the modern A horizon.