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DISCUSSION

THE EFFECT OF SEDIMENT TYPE ON THE SHAPE AND STRATIFICATION OF SOME MODERN FLUVIAL DEPOSITS

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In a recent paper, Schumm (1960) proposed the hypothesis that the weighted mean percent of silt and clay contained in the channel and bank deposits of valleys in semiarid regions is of primary importance in determining the width-depth ratio of these channels. To illustrate this relation, Schumm presented a graph (fig. 1, p. 179) showing the regression of channel width-depth ratio (W/D = F) against the weighted mean percent silt and clay (M); the graph shows a high degree of negative correlation between the two variables (r = –.91), indicating, hypothetically, that relatively broad, shallow channels are associated with channel and bank deposits with low silt and clay content, and relatively narrow, deep channels are associated with channel and bank deposits with high silt and clay content. This appealing hypothesis, unfortunately, is not supported by the material Schumm presents. The reason is simple: the variable M, weighted mean percent silt and clay, as defined by Schumm, contains the variable F or W/D, width-depth ratio, in disguised form.

Schumm defined the variable M as follows:

$$M = \frac{Wm_1 + 2Dm_2}{W + 2D}, \tag{1}$$

where W is channel width, D is channel depth, m_1 is the percent of silt and clay in the channel deposit, and m_2 is the percent of silt and clay in the bank deposit (1960, p. 178). If the percentages of silt and clay in the channel deposit and bank deposit are identical, then $m_1 = m_2 = M$. If m_1 and m_2 differ, as is most commonly the case in ephemeral streams, M will contain information about the channel shape.

In plotting values of F against M, Schumm was essentially saying that

$$F = W/D = f\left(\frac{Wm_1 + 2Dm_2}{W + 2D}\right); \tag{2}$$

f( ) stands for some functional relationship. If we assume, for simplicity, that $m_1 = 0$, $m_2 = 50\%$, and insert these values into equation 2, we find that

$$W/D = f\left(\frac{100D}{W + 2D}\right), \tag{2a}$$

that is, $M_{0,50} = 100D/(W + 2D)$. It is easily seen that W/D and $M_{0,50}$ are mathematically dependent. For every value of W/D there is a unique value of $M_{0,50}$. The relation between the two variables is inverse, as can be seen by reference to figure 1. One can select other values for m_1 and m_2, and as long

as $m_1 < m_2$, the relation between W/D and M will similarly be inverse. For example, if $m_1 = 5\%$, $m_2 = 75\%$, then

$$W/D = f\left(\frac{5W + 150D}{W + 2D}\right). \tag{2b}$$

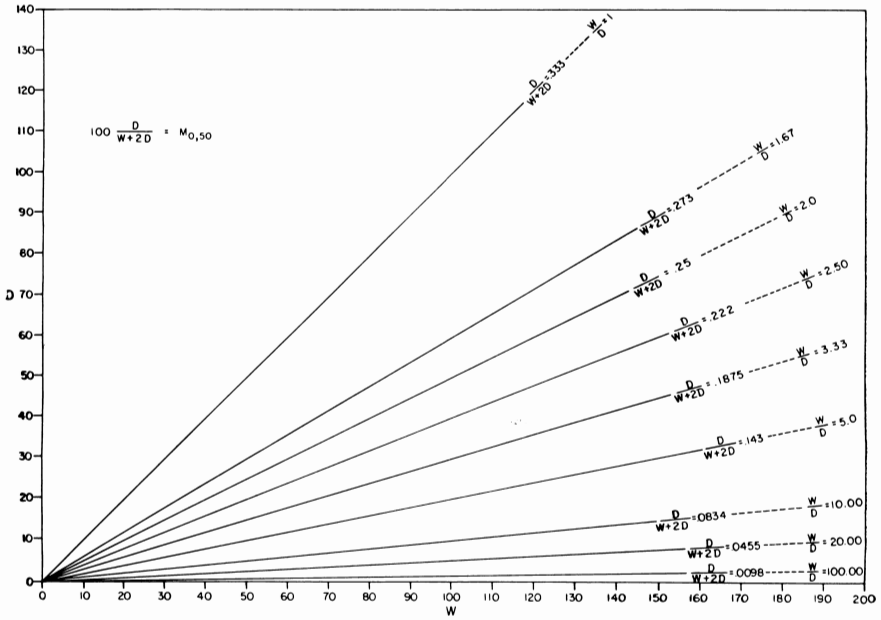

Fig. 1.

Table 1 lists values of W/D and $M_{5,75}$.

TABLE 1

Values of W/D and M. when $m_1 = 5\%$, $m_2 = 75\%$

W/D	$M_{5,75}$
1	51.8%
2	40.0
5	25.0
10	16.7
20	11.4
100	6.38

The values of W/D and M in table 1 can be plotted on Schumm's graph and will be found to fall mostly within the range of scatter of his data points, although with a steeper mean slope.

If $m_1 > m_2$, that is, if there is a *greater* percentage of silt and clay in the channel than in the bank deposits, there will be a direct relation between the width-depth ratio and M. Assuming $m_1 = 50\%$, $m_2 = 0$, then

$$W/D = f\left(\frac{50W}{W + 2D}\right). \tag{2c}$$

Table 2 lists values of W/D and $M_{50,0}$.

TABLE 2

Values of W/D and M, when $m_1 = 50\%$, $m_2 = 0$

W/D	$M_{50,0}$
1	16.7%
2	25.0
5	35.7
10	41.7
20	45.4
100	49.0

Some of the variation in M is surely due to variation in the silt and clay percentages in the bed load and bank deposits; exactly how much is not known. However, except in the special case. $m_1 = m_2$, a large proportion of the variation in M is due to variation in W/D, for purely mathematical reasons. It is therefore incorrect to correlate statistically sample values of channel width-depth ratio with the weighted mean percent silt and clay (M) as defined by Schumm. By doing so, Schumm introduced a fallacious, high degree of correlation which obscures the actual relations in nature. The fact that Schumm obtained a negative correlation between W/D and M merely indicates that in the majority of his samples the channel deposits contained less silt and clay than did the bank deposits.

Schumm states (1960, p. 178) that he was unable to obtain a significant correlation between channel width-depth ratio and any absolute measure of channel or bank deposit grain size. It is difficult to see in what way changing to percentages of silt and clay would expose a true correlation as high as –.91 that could not be detected by using median grain size as the measure. A higher percentage of silt and clay would surely result in a smaller median size, assuming approximate log-normality. Perhaps the best explanation is that the postulated correlation between channel shape and deposit grain size is actually much lower than indicated, and Schumm's sample was too small to detect it.

Correct statistical methods exist which would permit examination of possible relations between channel shape and texture of channel and bank deposits. It would be preferable to treat measures of bed-load grain size and bank-deposit grain size as two distinct variables. Either the logarithm of the median grain size or the percent silt and clay could be used, although the former might be preferable for statistical reasons. Multiple regression analysis of channel width-depth ratio against measures of channel and bank texture would show (1) whether channel and bank texture taken together have any effect on channel cross-sectional shape; (2) whether channel texture has a greater effect on channel shape than does bank texture, or vice versa; (3) whether neither channel texture nor bank texture has any discernible effect on the channel shape characteristics.

REFERENCE

Schumm, S. A., 1960, The effect of sediment type on the shape and stratification of some modern fluvial deposits: Am. Jour. Sci., v. 258, p. 177-184.