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The influence of grain size on channel patterns in a numerical model of alluvial rivers

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River channel patterns refer to the different aspects that natural rivers display in planform geometry. Since Leopold and Wolman (1957), the simplest classification separates patterns into single-thread (one channel, such as sinuous or straight rivers) and multi-thread (several channels, as in braided rivers) channels. A fundamental question motivating sedimentologists, geomorphologists and hydraulic engineers is: what factor or combination of factors determines the channel pattern of a river? From field data, experiments, and analytical studies, a large variety of controls on river patterns have been suggested (see e.g., Knighton, 1998), including valley gradient, flow regime, sediment supply (quantity and quality), vegetation, erosional history and local physiography. Among these, the caliber of the sediments in transport appears to be the first-order control emerging from casual observation as well as from most studies plotting river data (e.g., Lewin and Brewer, 2001; van der Berg, 1995). Though particular exceptions exist, multi-thread braided rivers are usually bedload rivers transporting coarse grain sizes, and single-thread sinuous or meandering rivers more often transport finer sediments in suspension or both in suspension and on the bed (mixed-load). However, it is apparent in texts (e.g., Knighton, 1998; Miller and Gupta, 1999; Mosley, 2001), that beyond this observation there is still no simple explanation as to why grain size plays such an important role in the patterning process. To our knowledge, the simple question of why a river develops one or several channels still does not have a clear answer.

To further understand the importance of grain size in determining channel patterns we use a numerical model similar in philosophy to that of Murray and Paola (1994, 1997;

hereafter MP) but in which the erosion/deposition balance is quantified by a transfer length for sediments that acts as a proxy for grain size. We show that the planform pattern of a river, whether single- or multi-thread, its dynamics and width, and its equilibrium slope are all controlled by local deposition in the river, which is in turn controlled by grain size for constant water discharge and sediment flux.

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