A new method to determine the structure and porosity of fluvial deposits

The pore structure of the river bed

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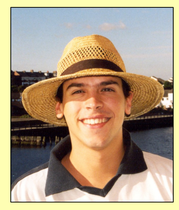


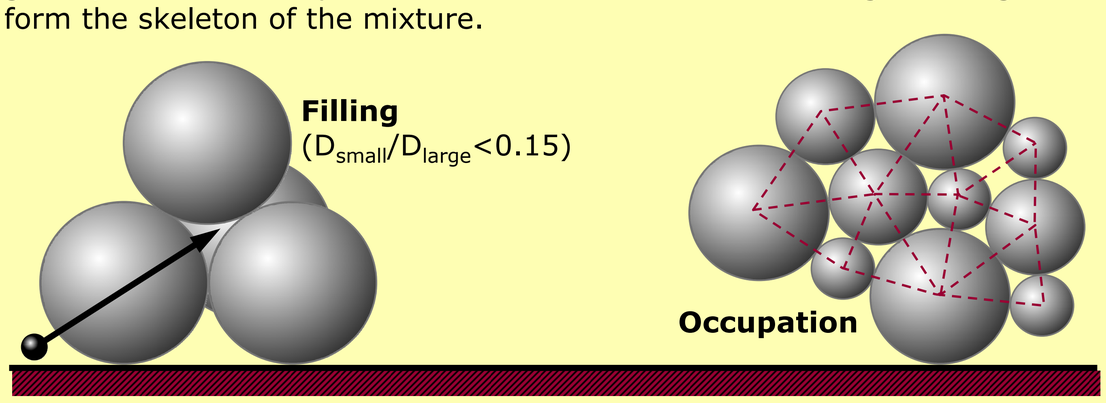
Introduction

Spatial variations in bed porosity have received little attention in fluvial geomorphology, although they strongly influence the rate of bed level change in aggrading and degrading river reaches. The objectives of this study were: (1) to select a porosity predictor suitable for fluvial deposits; (2) to investigate the variations in porosity and bed structure in the river Rhine; and (3) to propose a new sediment classification, based on the pore structure of the river bed.

1. Porosity prediction in fluvial sedimentology

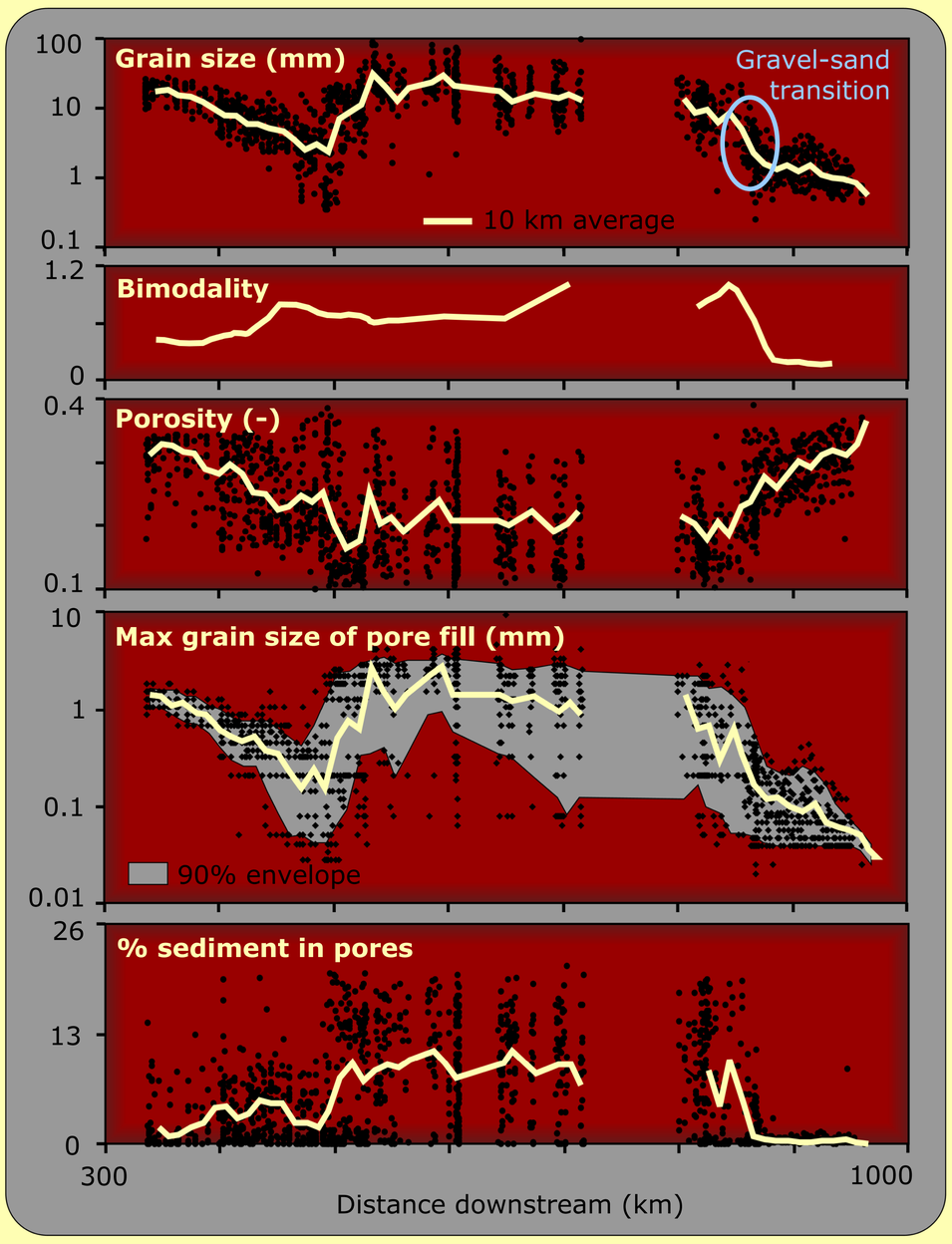
Porosity predictors used in fluvial research often relate the porosity to the standard deviation of the sediment. The predictors are not generally valid, because they do not distinguish between different packing mechanisms.

The two main packing mechanisms in sediment mixtures are filling and occupation. *Filling* means that fine grains percolate into the pores of larger grains, whereas *occupation* means that fine and coarse grains together form the skeleton of the mixture.



A porosity predictor that distinguishes between filling and occupation was developed by Yu & Standish (1991) for industrial use. This semi-empirical model, which only requires grain size distributions as input, was adapted and validated for fluvial sediments by Frings et al. (2008). The model predicts porosity, but also determines whether a sediment mixture is clast-supported or matrix-supported.

2. Case-study: the river Rhine



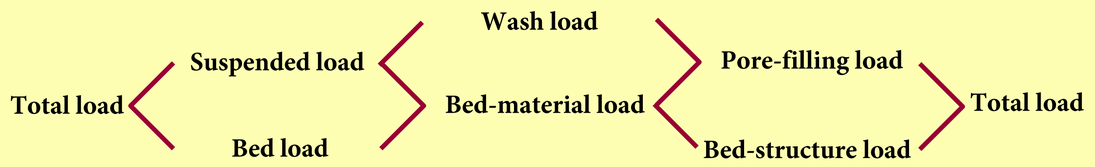
Application of the porosity model to the river Rhine shows that:

- The porosity ranges from 0.15 to 0.35.
  (*Considerably less than the often-used value of 0.40*)
- The max. grain size of the pore fill decreases from 2 to 0.05 mm, covariant with the downstream fining of bed sediments.
  (*Grain size fractions that fill the pores in the upstream part of the river thus gradually become part of the bed framework in the downstream part of the river)*
- The gravel-sand transition (km 845-875) is marked by a sudden increase in porosity and a rapid transition from a clast-supported to a matrix-supported river bed.
- Unimodal sediment = empty pores; bimodal sed. = filled pores.

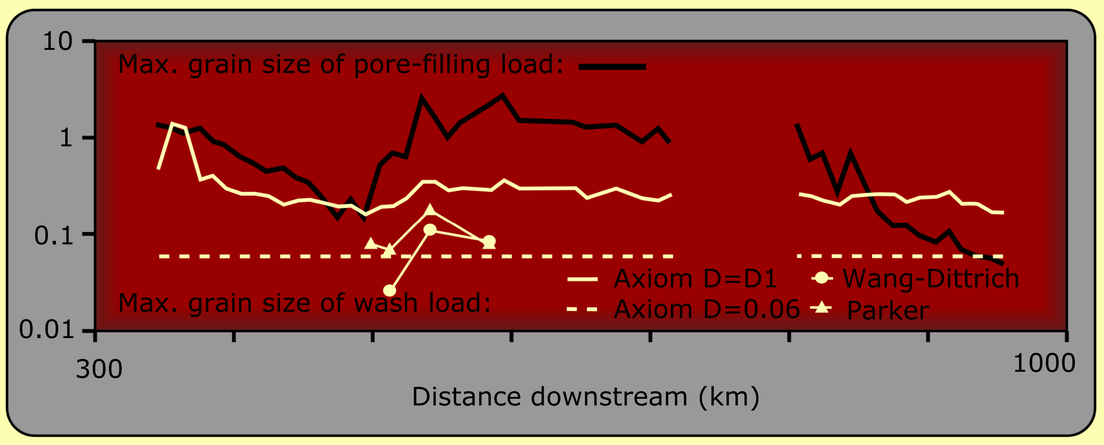
  Note that there are large variations in bed structure on small scale, caused by local sorting processes such as bend sorting and dune sorting.

3. A new classification of sediment transport

Based on the foregoing, the sediment load in a river can be divided into (1) pore-filling load (grains that infiltrate into the pores of the river bed) and (2) bed-structure load (grains that become part of the bed structure). For morphological predictions, only the bed-structure load is relevant, because pore-filling load does not contribute to bed level changes.



Pore-filling load should not be confused with wash load. Wash load is the finest part of the sediment load, for which the transport rate is governed by the upstream sediment supply. The amount of wash load in the river bed is negligible, whereas the amount of pore-filling load can be >20%. Application of several wash-load predictors to the river Rhine shows that wash load in general is an order of magnitude finer than pore-filling load.



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The research presented on this poster was part of the PhD research of R.M. Frings. Ask for a free copy of the thesis!

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