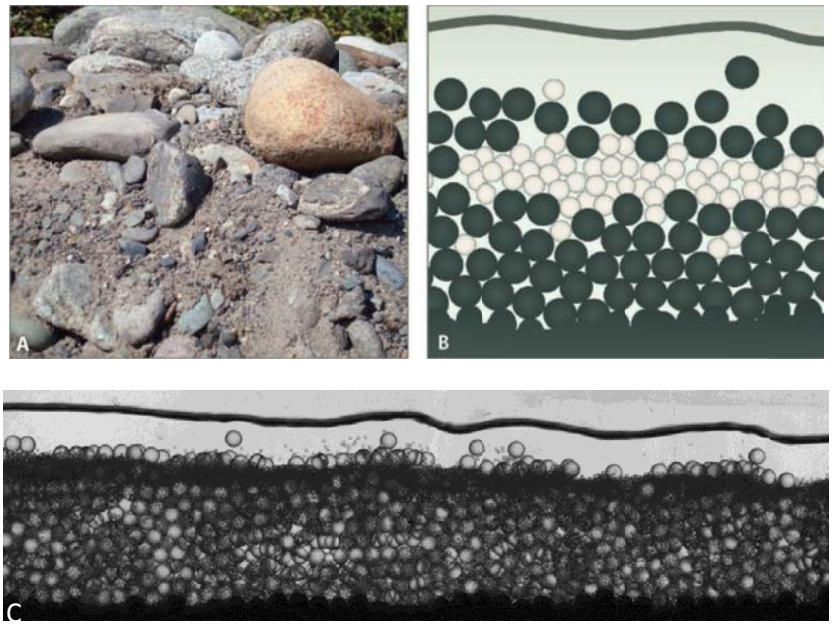
Segregation processes in bedload sediment transport: experimental and theoretical study

Bedload transport, the coarser bed material shear-driven by the turbulent water flow, has major consequences for public safety through flood alleviation, for the management of water resources, and for environmental sustainability. Despite 100 years of modern research, bedload sediment transport is still a scientific issue because of the phenomenon of size segregation also termed grain size sorting. Therefore engineering and operational tools are still very imprecise. We propose to change the viewpoint by concentrating on granular interactions (Frey and Church 2009).

The general objective is to experimentally investigate vertical size segregation, concentrating on granular interactions. One specific objective is to cast light on the asymmetry observed in segregation. Surprisingly enough, a small grain surrounded by large grains moves down vertically more rapidly than a large grain moving upward in a crowd of small grains. Yet, simpler 'symetric' models consider the same segregation rates in both cases!

Experiments and image analysis will be carried out in the narrow particulate channel at IRSTEA (Dudill et al; 2017), Grenoble and will give datasets to propose new segregation theories. These datasets will also permit validation (Maurin et al. 2015) of fluid/grain coupled discrete element models (the candidate may participate depending on profile and timeline). Experimental data jointly with numerical results should crack the case of asymmetry in segregation.



A. River armoring B. Segregation by kinetic sieving C. degradation by fine material segregation

P. Frey, HdR will be supervising this PhD. In the framework of the ANR SegSed project 'Size Segregation in sediment transport' (coord P. Frey), this PhD will benefit from collaborations with University of Manchester (N. Gray) and SFU, Vancouver, Canada (Dept of Geography, J. Venditti) where additional experiments could be carried out.

Other collaborations include LEGI, Univ. Grenoble Alpes (J. Chauchat), Laboratoire Hubert Curien, université de St-Etienne (C. Ducottet, analyse d'image) and IMFT, Univ. Toulouse (R. Maurin).

Candidate profile: fluid mechanics or Earth science or granular physics, with a strong interest in experimental research.

Required : an excellent academic level, a very good level of English and a programming experience (matlab, python, C++, …).

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Frey P, Church M. 2009. How river beds move. Science 325(5947): 1509-1510.

Dudill A, Frey P, Church M. 2017. Infiltration of fine sediment into a coarse mobile bed: A phenomenological study. Earth Surface Processes and Landforms 42(8): 1171-1185.

Maurin R, Chauchat J, Chareyre B, Frey P. 2015. A minimal coupled fluid-discrete element model for bedload transport. Physics of Fluids 27(11): 113302.