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Application of an Instrumented Tracer in an Abrasion Mill for Rock Abrasion Studies

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Understanding sediment dynamics is of great importance in the field of gravel-bed river research. Advances in computer technology have enabled us to use ever more sophisticated models of sediment transport. Our goal is to develop accurate theoretical models based on physical laws of solid body interaction to amend or replace current experimental models based on various regression coefficients. This development is based largely on accurate understanding of sediment particle movement. One of research fields in gravel-bed river research is the interaction between sediment transport and incision rates in rock-bottom river reaches. The main idea of laboratory experiments on rock abrasion was to help understanding the process and intensity of rock abrasion of fixed rock plates of different lithology in an abrasion mill by moving sediment particles, and then to transfer laboratory values of rock abrasion into the field. The material for signal analysis were obtained by putting the instrumented tracer (diameter = 99 mm, mass = 994.6 g, called SPY Cobble, measuring accelerations in 3D) together with a number of different mixtures of fluvial sediment (different mass and number of sediment particles as well as of different lithologies) into a Dubree type abrasion mill (33 revolutions per minute, mill diameter = 711 mm, mill length = 508 mm). Additionally a set of rock plates was fixed to the mill wall to evaluate rock abrasion by moving sediment particles. The problem to solve was how can we recognize and differentiate between impacts of the instrumented tracer with different bodies: sediment particles, rock plates, soft lining of the mill and steel side plates of the mill. An effective and computationally inexpensive algorithm for automatic impact recognition and evaluation was developed, based on time domain analysis. This enabled

us to break continuous accelerometer recording into parts, each containing one tracer impact, suitable for further analysis. We defined two values, which describe each recognized impact: α = 1/T and β = S/(1000 T), where S is the local signal maximum (peak amplitude) and T is the time period (s) when the signal is higher than (2/3 T). Using this algorithm it was possible to determine the material of the impacted object from the above-described parameters with a high degree of certainty. Frequency domain analysis has given a method of discriminating different signals. Both mentioned methods allow us to classify all recorded signals into groups based on similarity of measurement conditions.