

Public Abstract

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Title:ENTRAINMENT AND TRANSPORT OF COARSE STREAM BED MATERIAL IN A FLUVIOKARST WATERSHED, SOUTH-CENTRAL MISSOURI: A TRACER PARTICLE STUDY

The central U.S. is heavily karstified (contains well developed subsurface drainage systems) that are covered by beds of coarse-grained, heterogeneous sediments deposited by running water, and those sediments resemble those found in headwater surface streams. The movement of coarse sediment as bed load within karst streams has been considered negligible in the past as it was assumed that all karst is developed through dissolution rather than mechanical abrasion (from sediment transport). The frequency and magnitude of sediment transporting events in karst streams has implications for models of fluvio karst landscape development and the stability of aquatic ecosystems.

Within Tumbling Creek Cave (TCC) in the Ozark Plateau of south-central Missouri, and Bear Cave Hollow (BCH), one of the surface drainage streams of TCC, bed load entrainment and transport dynamics of coarse-grained (16-180 mm), mainly silica-rich material, was evaluated using hydrological measurements and 670 painted tracer particles. Tracers are used in this research for the first time in a karst stream. Tracers are well suited for studying the stochastic and spatially variable nature of bed load transport because they reflect the movement of individual particles of known characteristics, and they are also inexpensive and simple to employ.

Median surficial sediment grain size in the study reaches ranged from 39 to 71 mm in TCC, and from 24 to 37 mm in BCH with bed and/or water slopes ranging from 0.006 to 0.077 in TCC and from 0.002 to 0.009 in BCH. TCC is classified as a pool-riffle channel morphology type and BCH is classified as a plane-bed channel. Preliminary data from surveys of the longitudinal (downstream) movement of tracers over a 10-month period indicate that minor amounts (0-13.2%) of coarse bed material in TCC are mobilized by relatively low flows (5-28% of bankfull) that recur somewhat frequently (less than 3.1 years). BCH transports a higher percentage of material (0-59.1%) during similar flows (2-29% of bankfull) and frequencies (less than 3.59 years). Bed load transport was observed to be in a state of partial transport for any one grain size class in TCC during the study, while the complete mobilization of tracer size classes was observed in BCH at the highest observed flow, indicating phase 2 transport and the break-up of the armor layer. The differences are attributed to the wider observed range of grain sizes covering the bed in TCC compared to BCH.

The use of the Shields (1936) criteria tends to over predict the critical shear stress required for entrainment of the largest mobilized grain size of individual tracers, while the empirical equation of Bagnold (1980) performs much better. Thus, the Shields equation may be better suited as a gage for complete mobilization of a grain size class across a reach, while the Bagnold (1980) equation may be better suited for estimating entrainment of grains from patches of the bed.