

Joe - my summer
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My Sediments Exactly, or
Why We Care About Cobbles, Sand and Silt
In the Hawkins-Logsdon River of the
Flint Ridge-Mammoth Cave System

Rachel Bosch (1997)

The hydrology and geochemistry of the Hawkins River are included in an ongoing study which was begun by former park hydrologist James Quinlan. My studies of the sediments in this river use data which is acquired using the wells installed by Quinlan as well as his Doyel Valley entrance to the system. Other researchers actively involved in attempting to understand what is happening in the Hawkins River include the current park hydrologist Joe Meiman, Dr. Chris Groves, and Darlene Anthony. Information about the water, chemistry, sediments, and passage geology in this one area of the Mammoth Cave can lead to understanding of how cave rivers, in general, work to actively form new cave passageways. There are many reasons to study sediment transport, specifically, in Mammoth Cave. These include the aforementioned speleogenesis question, environmental reasons, the possibility of learning more about the hazards in karst terranes, and to help make a more complete picture of the Mammoth Cave system.

Sediment may contribute to cave passage development when it is being transported by underground rivers. Sediment transport can be divided into two categories: bedload and suspended load. The bedload is defined as all those rolling, saltating and colliding

grains which transfer momentum to the bed by solid-solid contacts. This type of transport occurs when the bed shear stress exceeds the critical shear stress, determined by the weight of the grains, the angle of the application of the stress, and the flow characteristics. The suspended load consists of all grains kept aloft by fluid turbulence such that the weight of the grains is balanced by an upwards momentum transfer from fluid eddies. The entrainment of grains in this manner is dependent upon the upward directed fluid velocity exceeding the grains settling velocity, which requires the weight and size of the grains and the fluid velocities (Slingerland).

Most erosion in surface stream channels, referred to as bed wear, is due to grains which are transported as bedload (Foley). This makes sense since the bed is the only place where sediment come into contact with the stream channel in a surface stream. However, in karst during high flow conditions, river conduits are acting as pipes filled with water and whatever the water carries along with it. These will be situations with high water velocities and therefore turbulent flows capable of moving incredible amounts of sediment as suspended load. This sediment can contact passage walls and ceilings, acting as tools to mechanically abrade the limestone bedrock.

The environmental problems which could be addressed from a sediment standpoint number at least two. There have been drastic changes in land use in West Central Kentucky over the past two centuries. These changes have affected the ways that sediment move throughout the landscape, which in turn have caused problems in the

ecosystem. A major example can be found in the Green River. Increased runoff due to farming on the Pennyroyal Plateau has caused an increased sediment flux through the Flint-Ridge Mammoth Cave system, as well as through other independent cave systems which discharge to the Green River. This increase in silt levels has had a dramatic adverse affect on native mussel populations in the river. According to Clarke, "Mussel abundance has been reduced by about 90% and diversity by about 50%," from 1958 to 1983. Studies in sediment transport can also be applied to contaminant transport, such as the transport of solid wastes or of pollutants which have an affinity for clastic sediment.

Sediment transport is also a key factor in soil piping sinkhole collapse. In order for a sinkhole to form, there needs to be a drain, such as a vertical shaft to pipe sediment downwards and a horizontal system below that drain to transport the soil away from the drain. A better understanding of sediment transport in karst could lead to a better understanding of the phenomenon of catastrophic sinkhole collapse, and perhaps better management of this hazard.

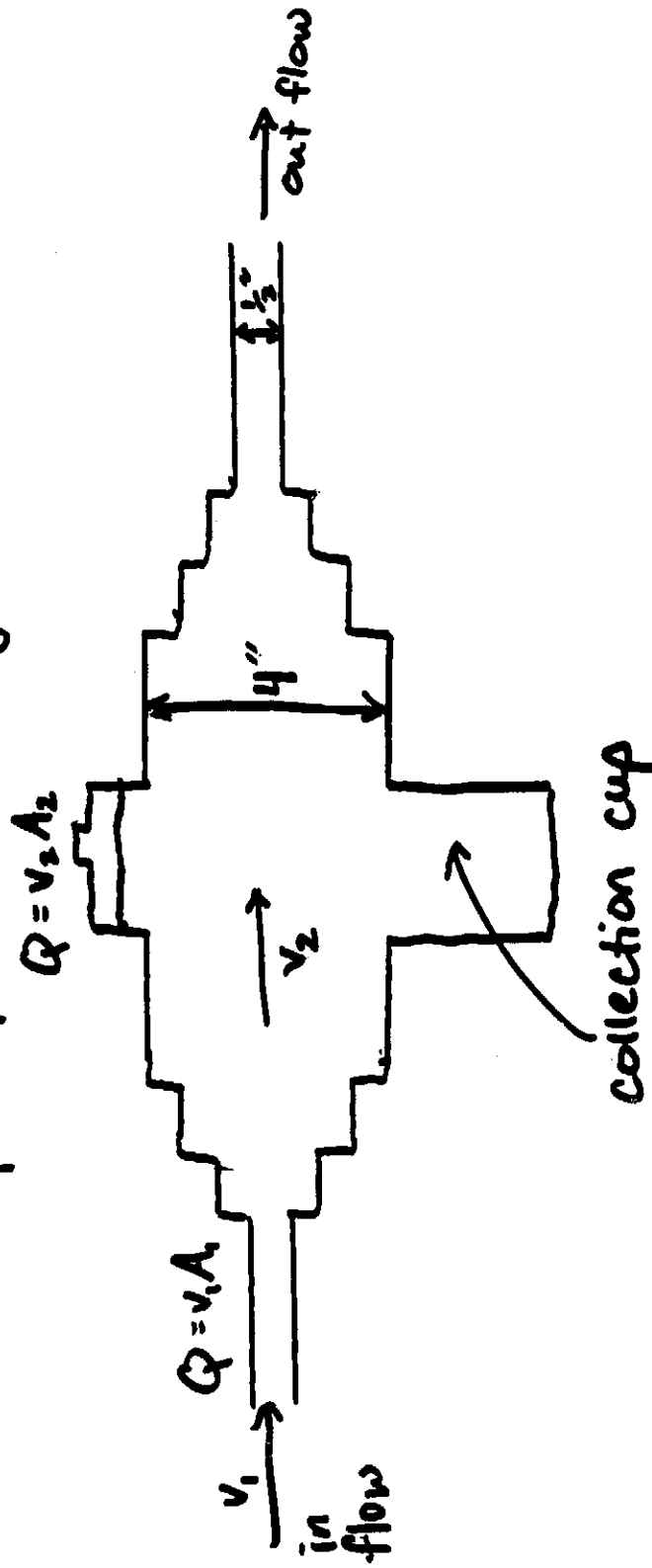
Finally, because sediment transport is something which occurs in the Mammoth Cave system, it is worthy of study. Data collected now on the location of sediments, their transport rates, specific transport events, and other details can help to provide a base of information against which to compare future events in the cave system. Anything which we can do to learn about this resource may be used in some way to better understand and protect it.

Appendix: Research Techniques

In studying sediment transport in the Hawkins-Logson River, I have, with the invaluable help of Joe Meiman, designed and constructed a sediment trap which has been installed at the Left Fork Well of the Hawkins River. See Figure for a diagram of this trap. The trap is constructed of PVC pipes and consists of an intake tube .5" in diameter which is connected to a central pipe of 4" diameter. The collection cup is located directly below the central pipe. When the water encounters the larger diameter pipe, it obeys the law of continuity, and therefore the velocity drops by a factor of 64. It is no longer capable of carrying the sediment in suspension and drops it into the cup.

SEDIMENT TRAP

schematic diagram and
principles of design



$$v_2 = \frac{1}{64} v_1$$

References

- Clarke A. H. (1983) The distribution and relative abundance of *Lithasia pingus*, *Pleurobema plenum*, *Villosa trabalis*, and *Epioblasma sampsoni*. *American Malacological Bulletin*. 1: 27-30.
- Foley M. G. (1980) Bed-rock incision by streams. *Geological Society of America Bulletin*. Part II, 91: 2189-2213.
- Slingerland R. (1997) Lecture notes. *Quantitative Physical Sedimentology*.

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