Modeling of bedrock channel and cave evolution using computational fluid dynamics

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Overview

- Introduction
- Existing literature on bedrock channel cross-section modeling
- Limits of cross-section models
  - Example of sediment influence
- 3D computational fluid dynamics (CFD) modeling
- Results
Motivation
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Numerical modeling of bedrock channel cross-sections

Numerical modeling of bedrock channel cross-sections
Sediment behavior

- Erosion is caused by sediment
- Local boundary shear stress is not the only variable influencing erosion rates along the boundary
Influence of sediment

- Tools effect: bedrock is abraded by bed load
- Cover effect: bed load protects bedrock from erosion
- Erosion is fastest when 1/2 surface is covered
Influence of sediment
Stability

- In stable cross-sections, bigger local bank slope means smaller erosion rate.
- If erosion rate maximum does not occur at the lowest point, the cross-section is unstable.
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Stability
Beyond steady-state assumption

- Cross-section (and slope) stays constant through time
- Cross-section (and slope) stays constant along the channel
Computational Fluid Dynamics (CFD)

- Using numerical methods to calculate fluid flow
- In our context: calculating fluid flow using some efficient universal software package developed by someone else (instead of crude methods we are able to implement)
Lattice-Boltzmann Method

- Used in our group to look at turbulent flow structures over soluble bedforms
- Joe Myre, 345-12, Wednesday 4:05pm
OpenFOAM

- Open source CFD package
  - calculates flow through a 3D channel segment
  - calculates shear stress on the wall
OpenFOAM results
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