

# Modeling of the effects of water and sand discharge on sand deposition in archeologically significant reaches of the Colorado River in Grand Canyon

Stephen Wiele  
Margaret Torizzo

U.S Geological Survey



# Possible linkages between dam closure and gully development

Hereford, Fairley, Thompson, and Balsom –

1. Erosion of sand bars
2. Lowering of riverside base level
3. Persistent gully development



# Possible linkages between dam closure and gully development



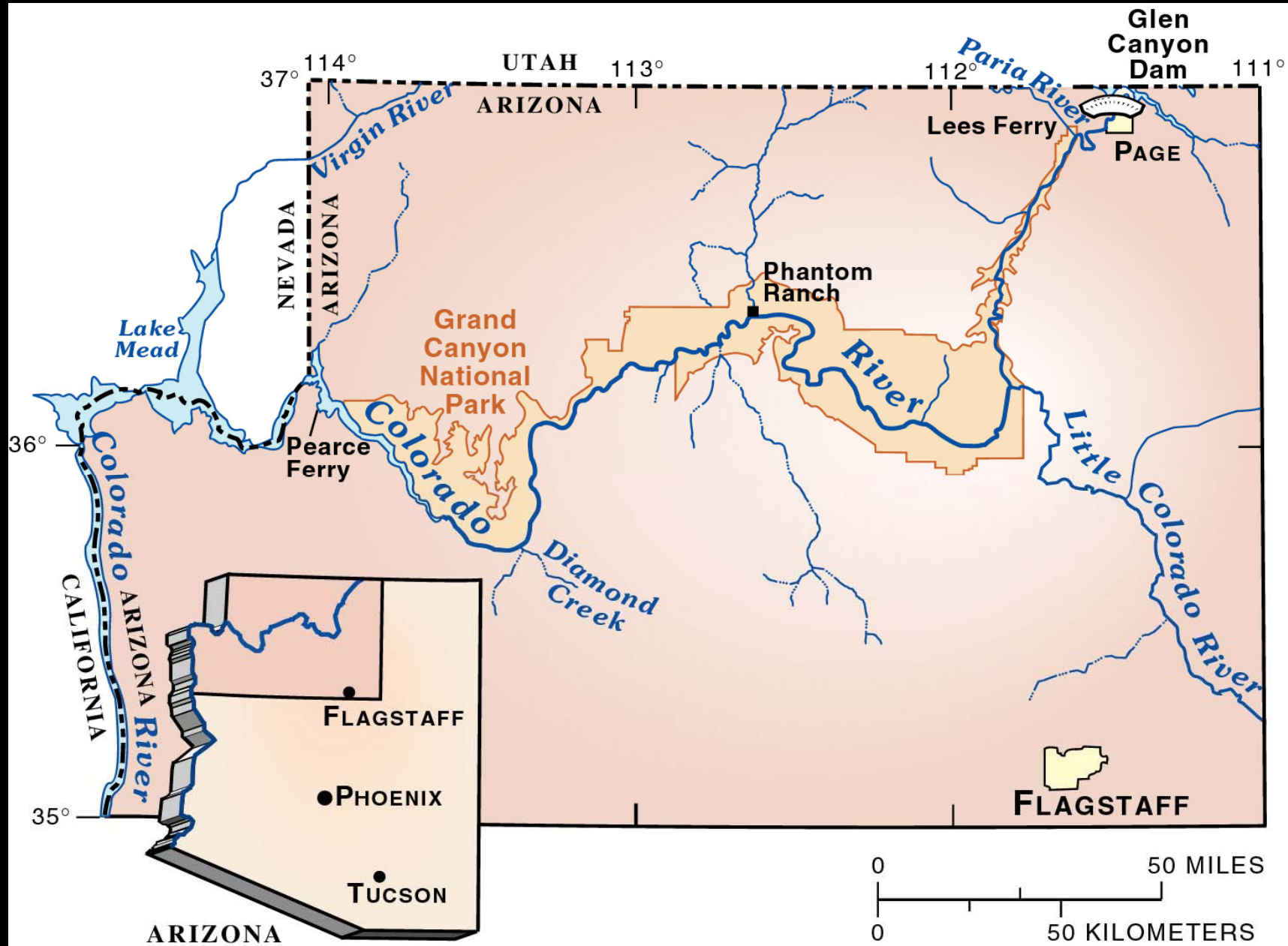
## Eolian processes –

1. Erosions of sand bars
2. Diminished source for wind-blown sand
3. Incipient gullies no longer filled in

# Cultural resources

How effective would high releases be in depositing sand in gullies in reaches with vulnerable artifacts?





## Model of flow, sand transport, and bed evolution

- calculate vertically averaged flow field

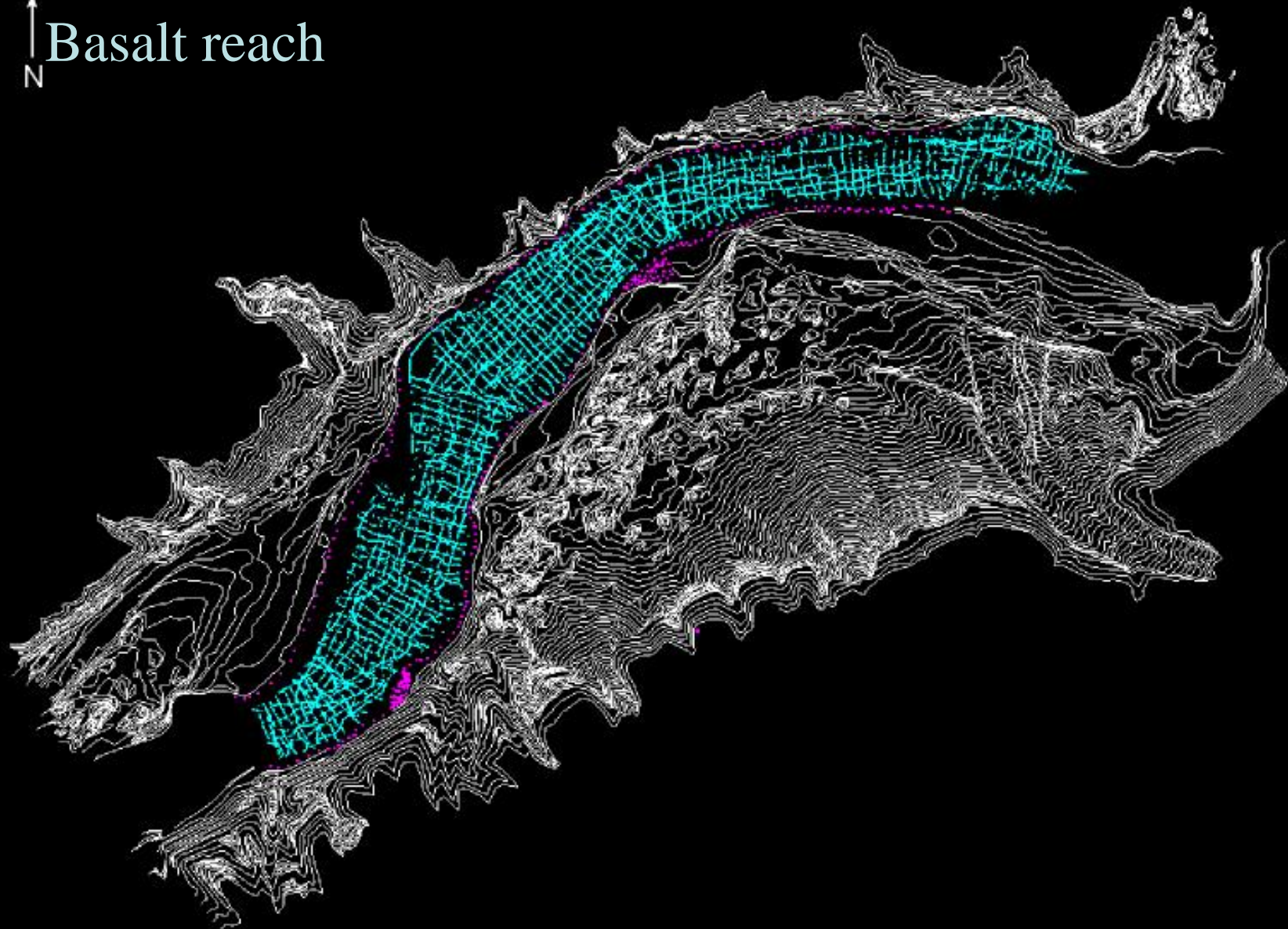
- calculate 3d suspended sand field

- calculate local sand discharge

- calculate change in bed elevation over a small time step

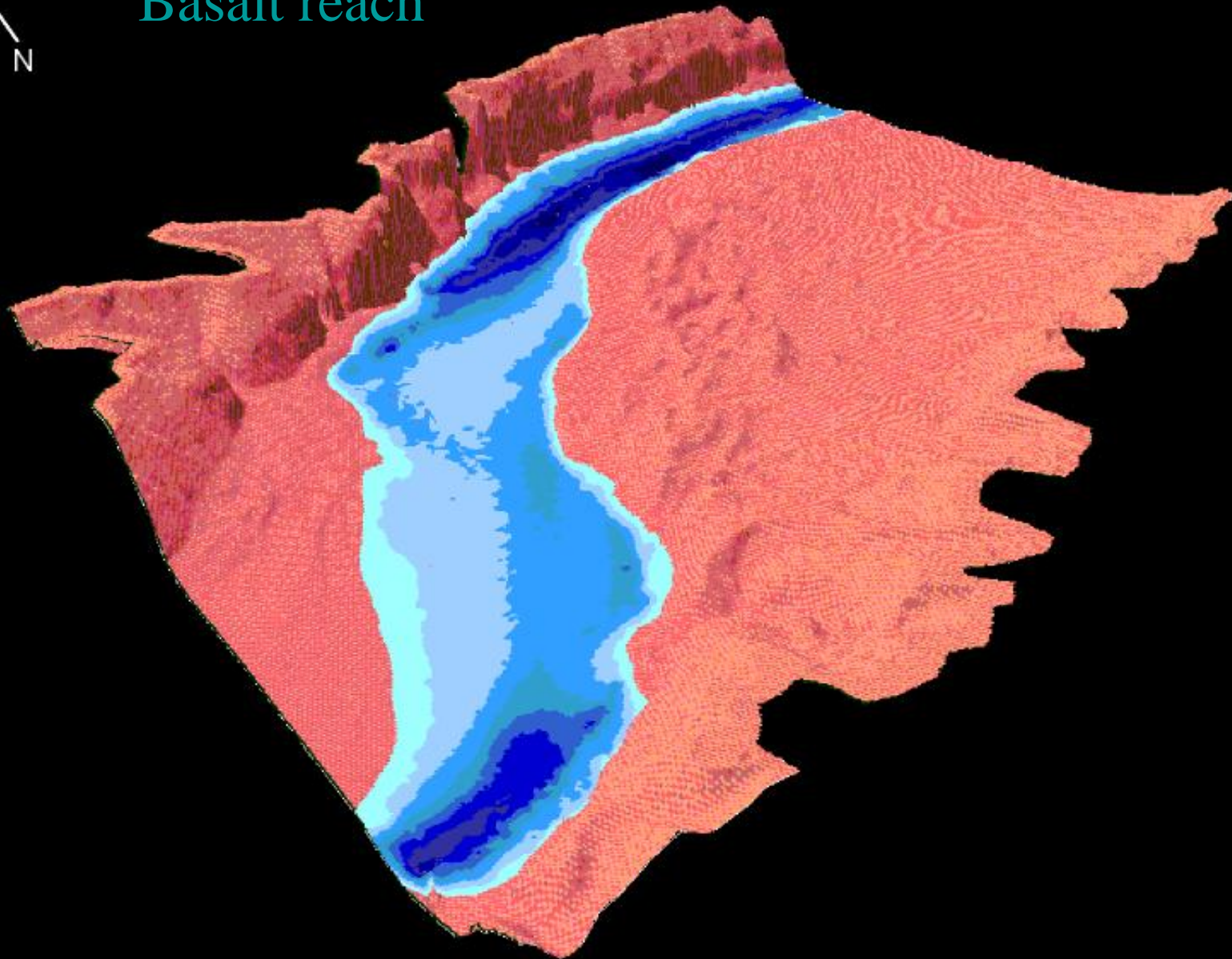


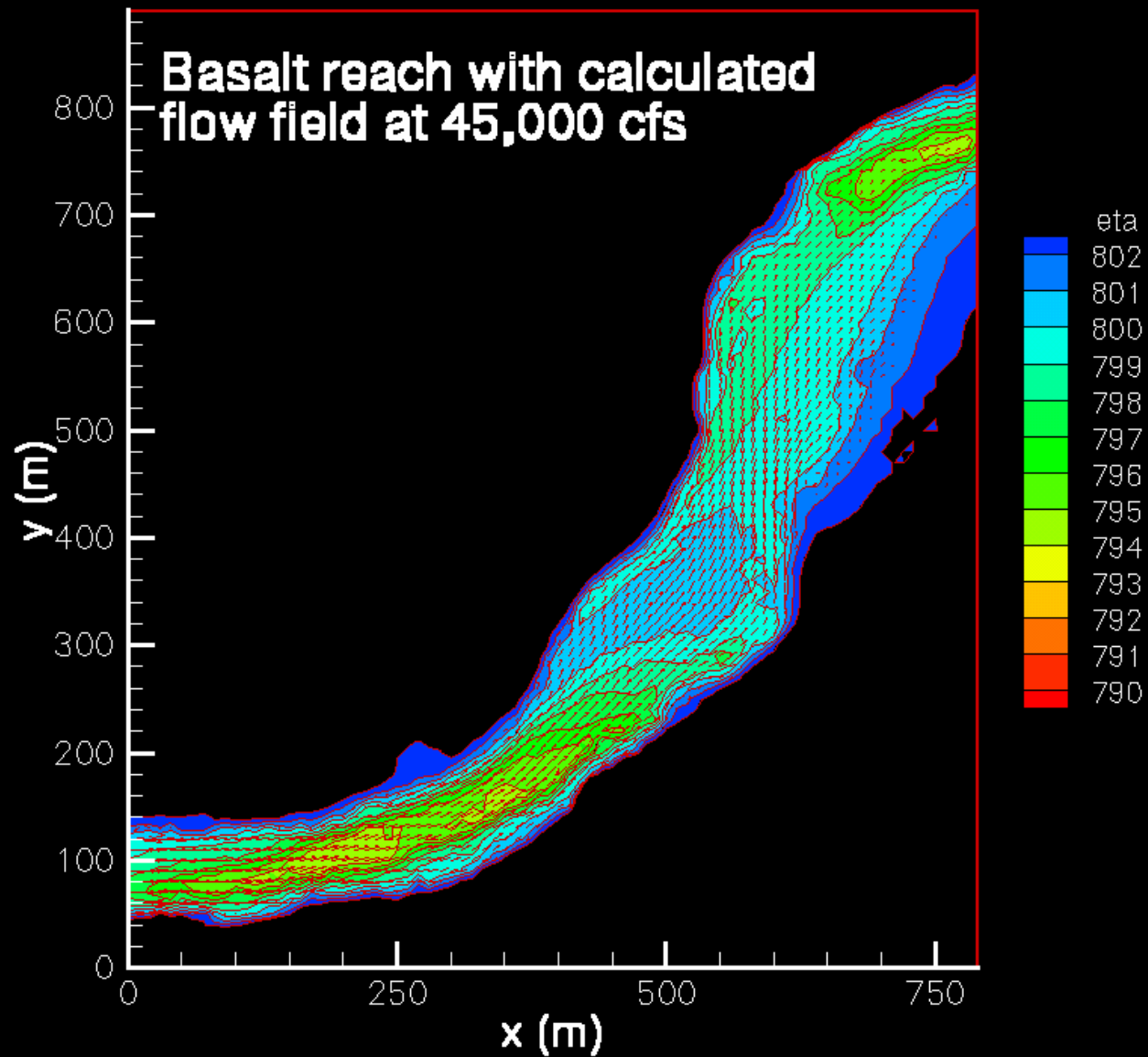
↑  
N  
Basalt reach





Basalt reach



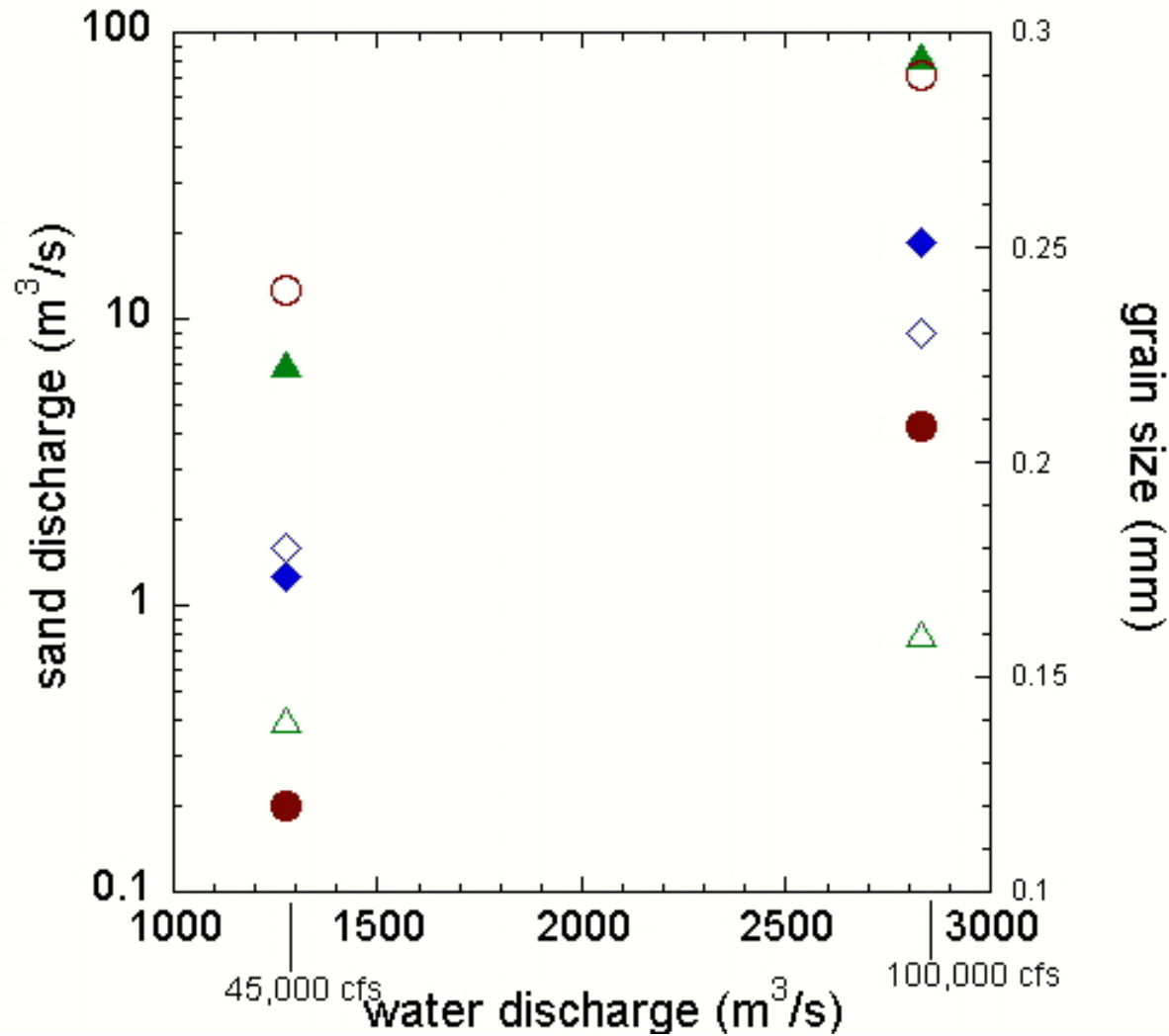


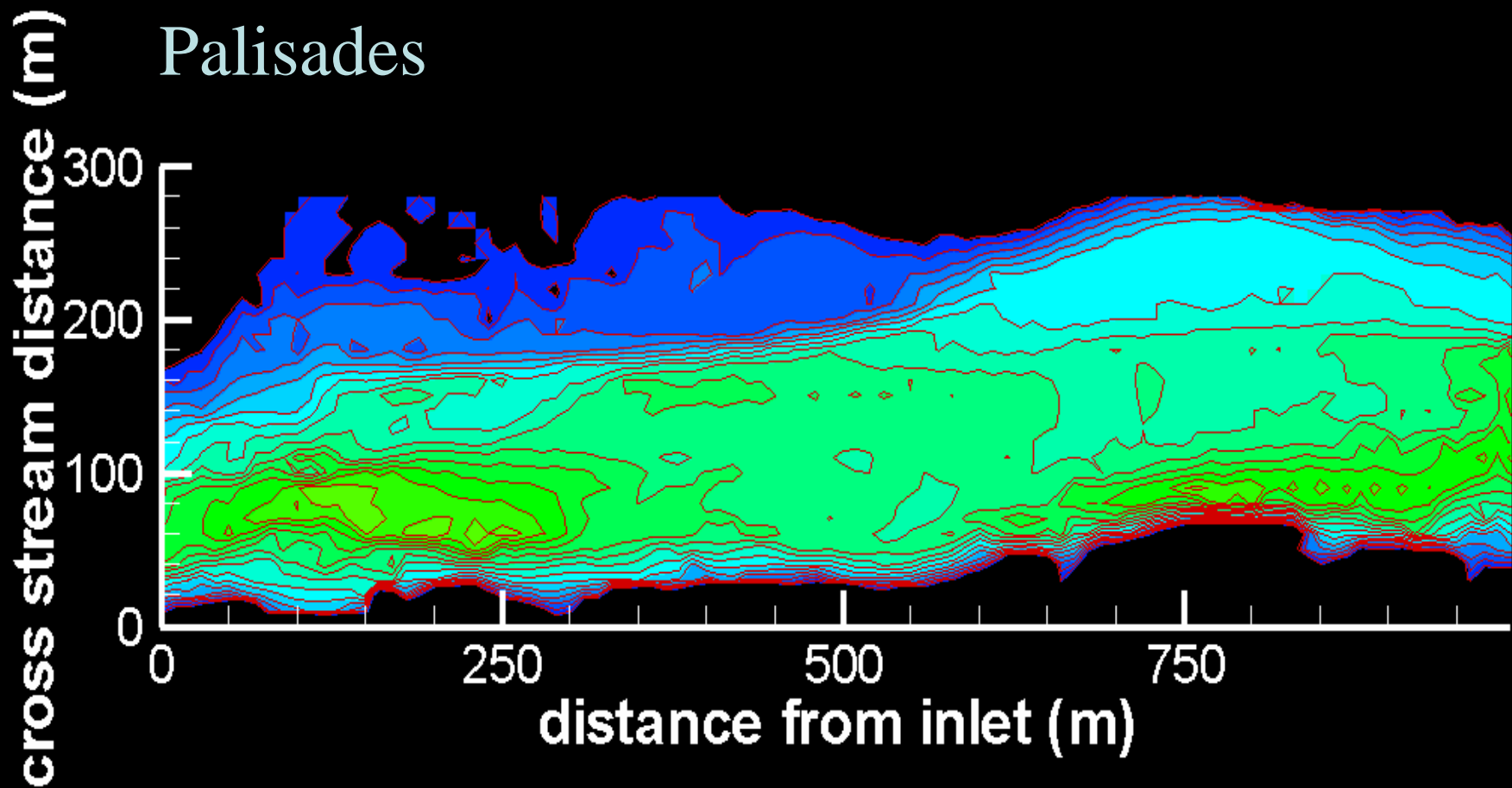
Six cases:

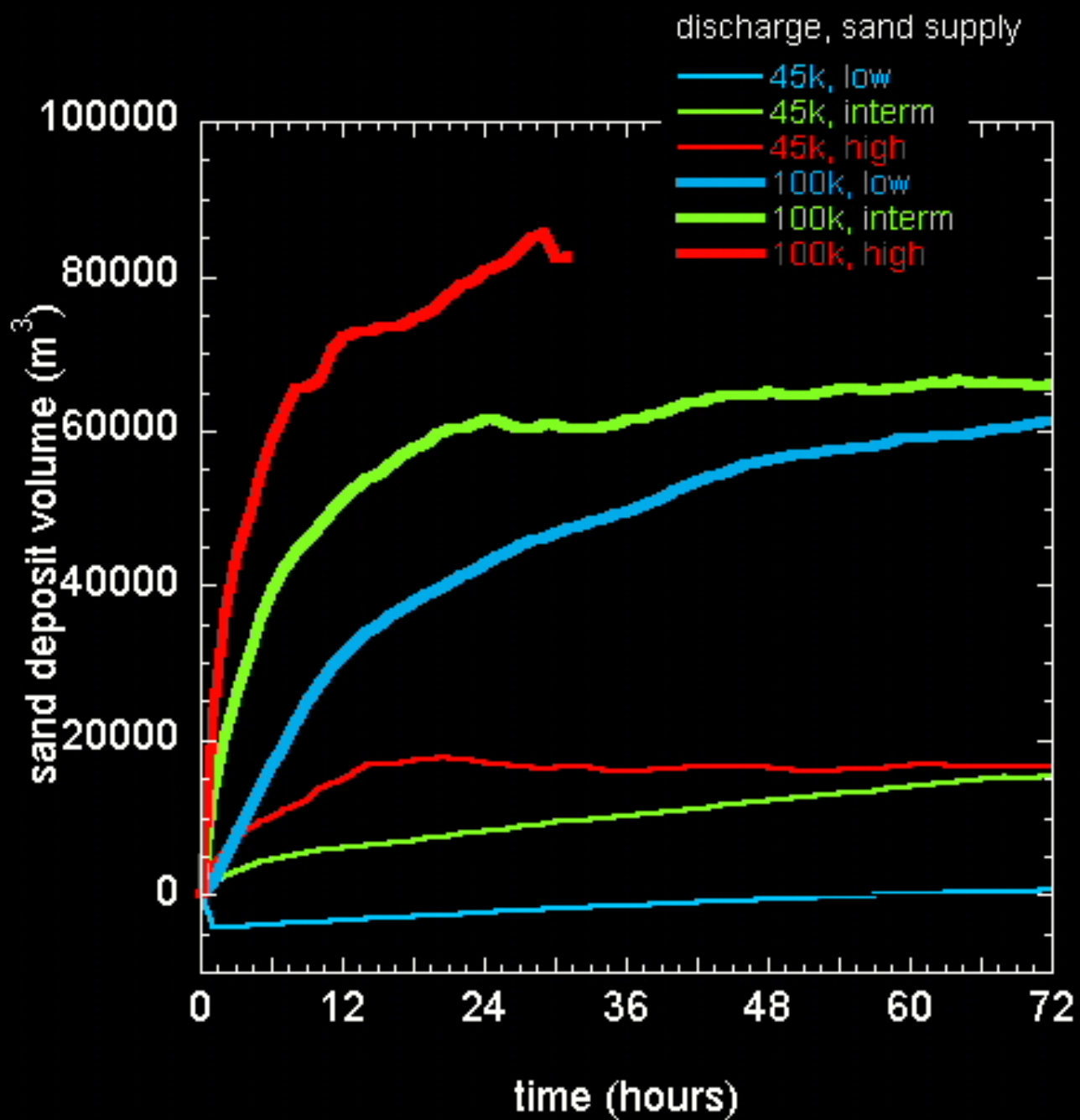
- Low, medium, and high sand supplies
- 45k and 100k cfs discharge

- |                       |                      |                   |                      |
|-----------------------|----------------------|-------------------|----------------------|
| <b>sand discharge</b> |                      | <b>grain size</b> |                      |
| ●                     | 1983 sand conditions | ○                 | 1983 sand conditions |
| ◆                     | 1996 sand conditions | ◇                 | 1996 sand conditions |
| ▲                     | 1956 sand conditions | △                 | 1956 sand conditions |

From Topping,  
written communication, 1999

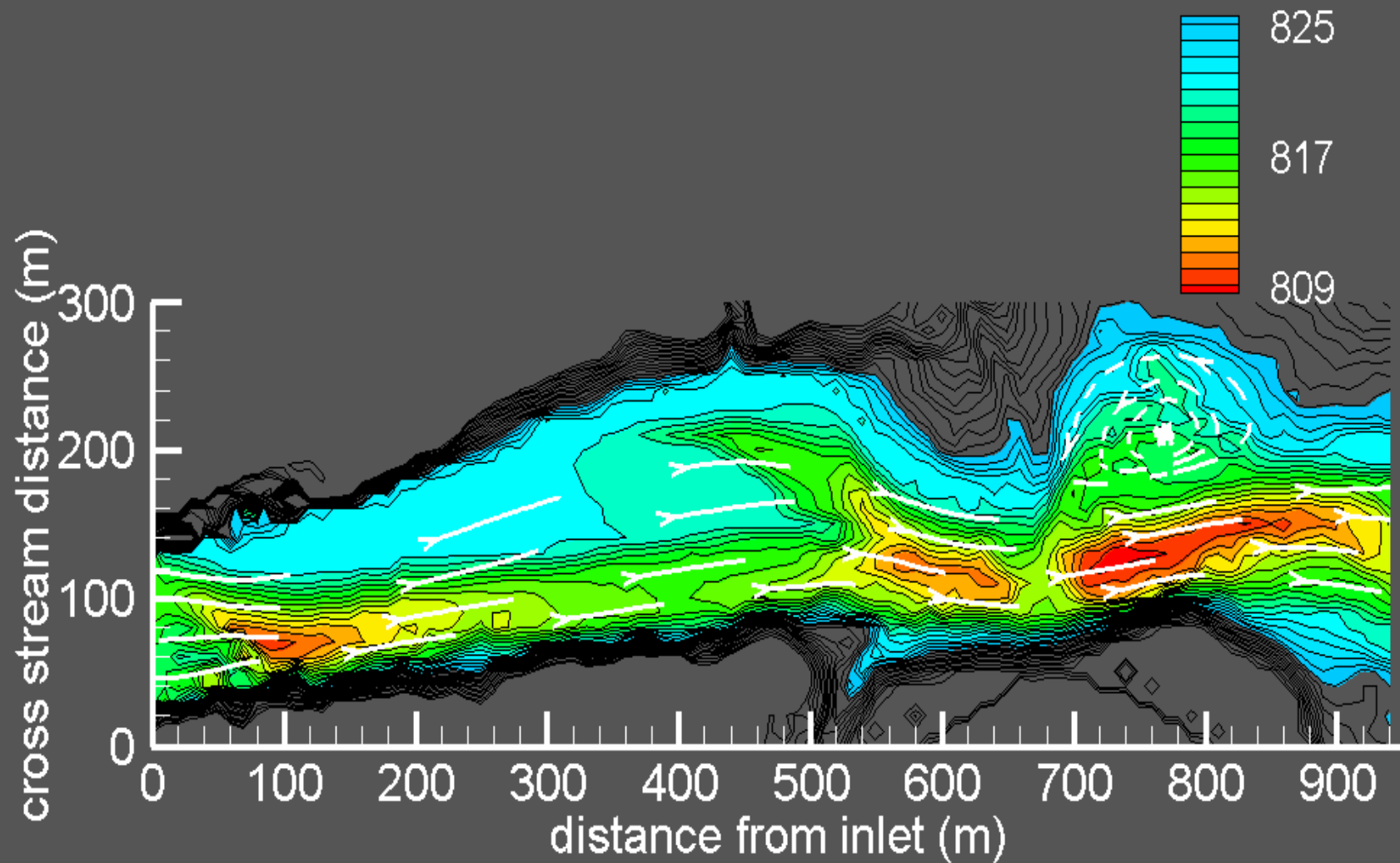


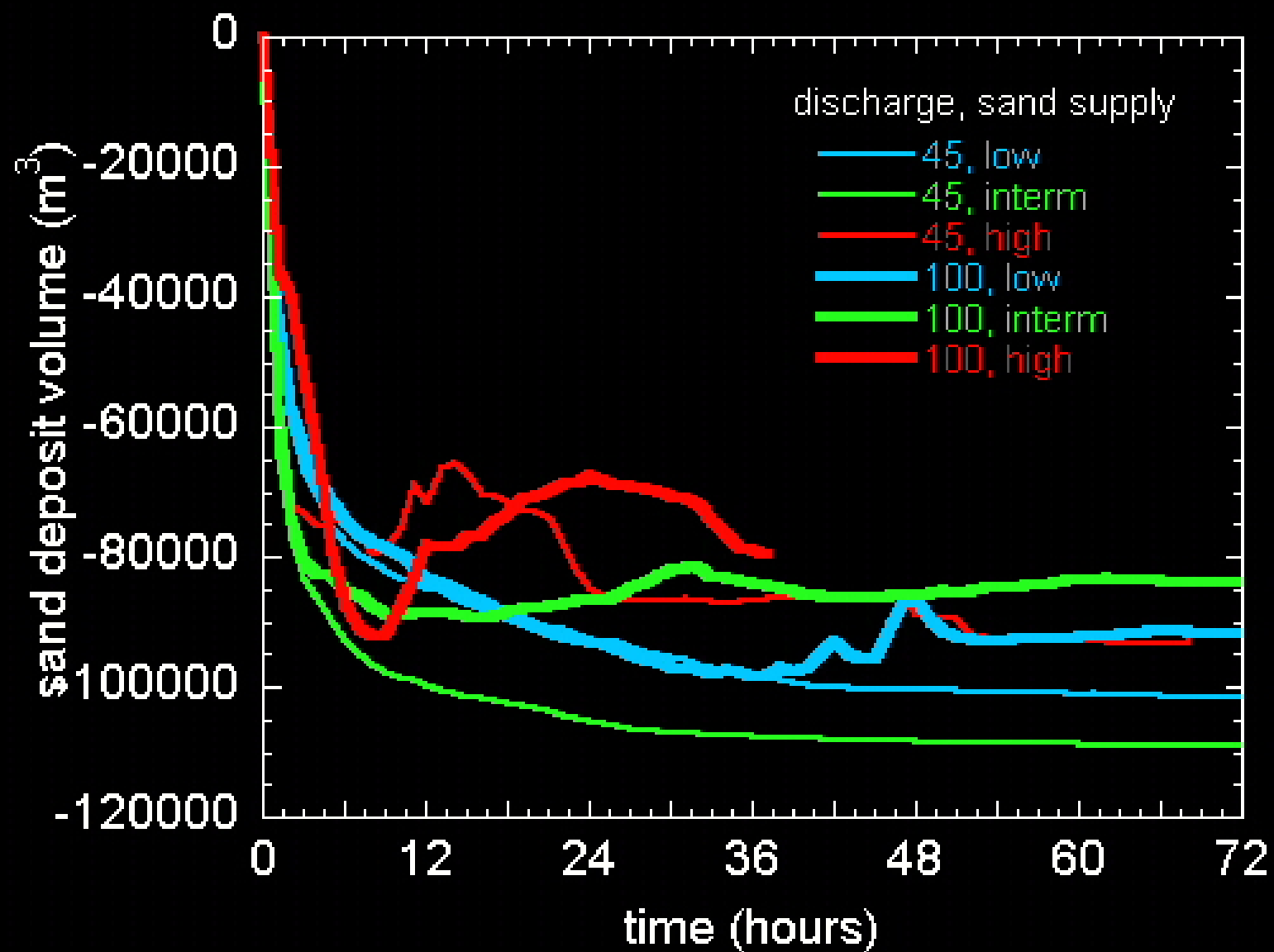




above Lava Chuar

bed elevation (m)

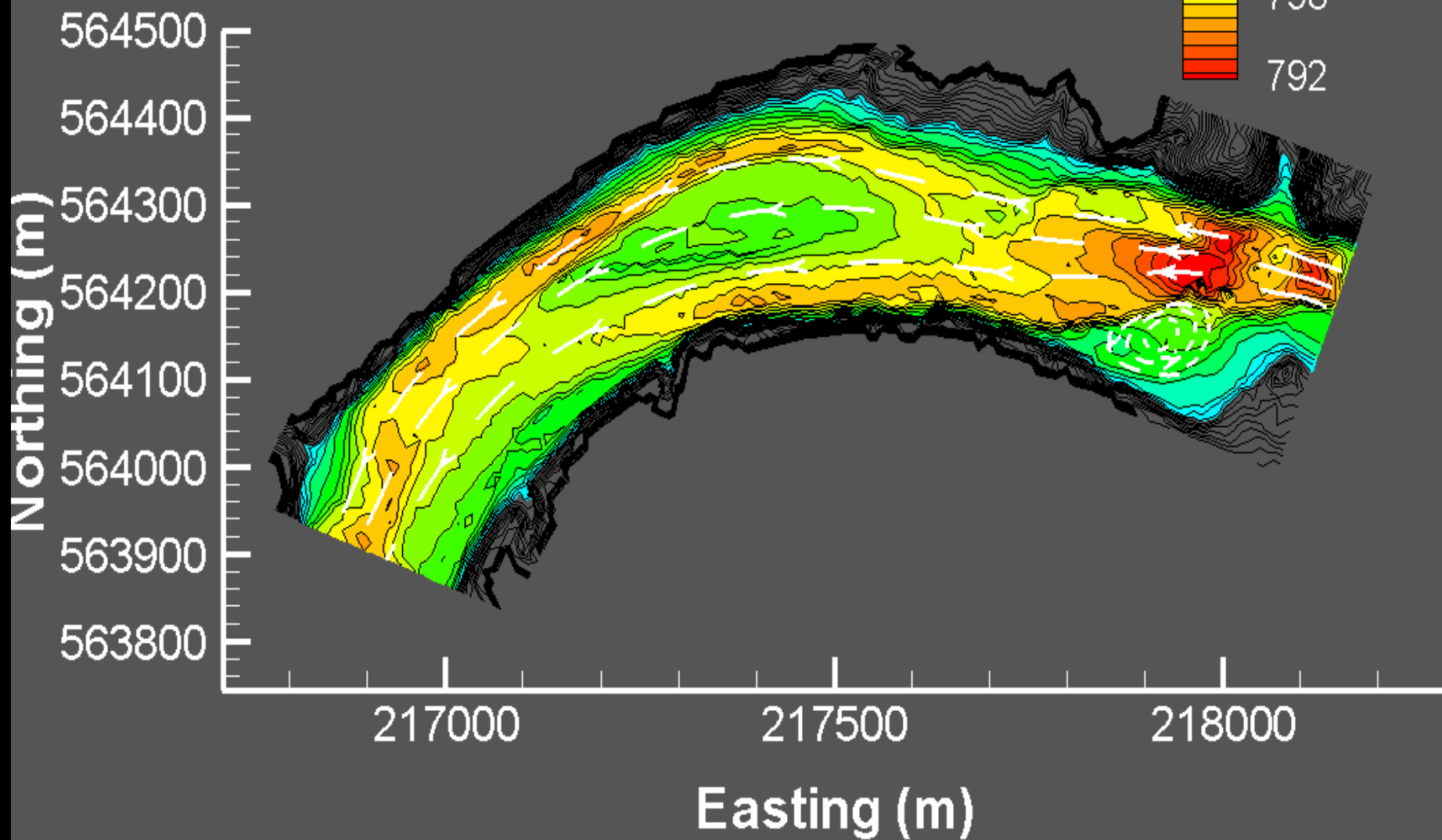
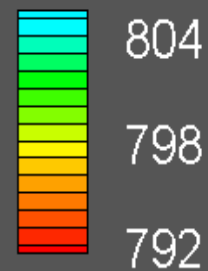




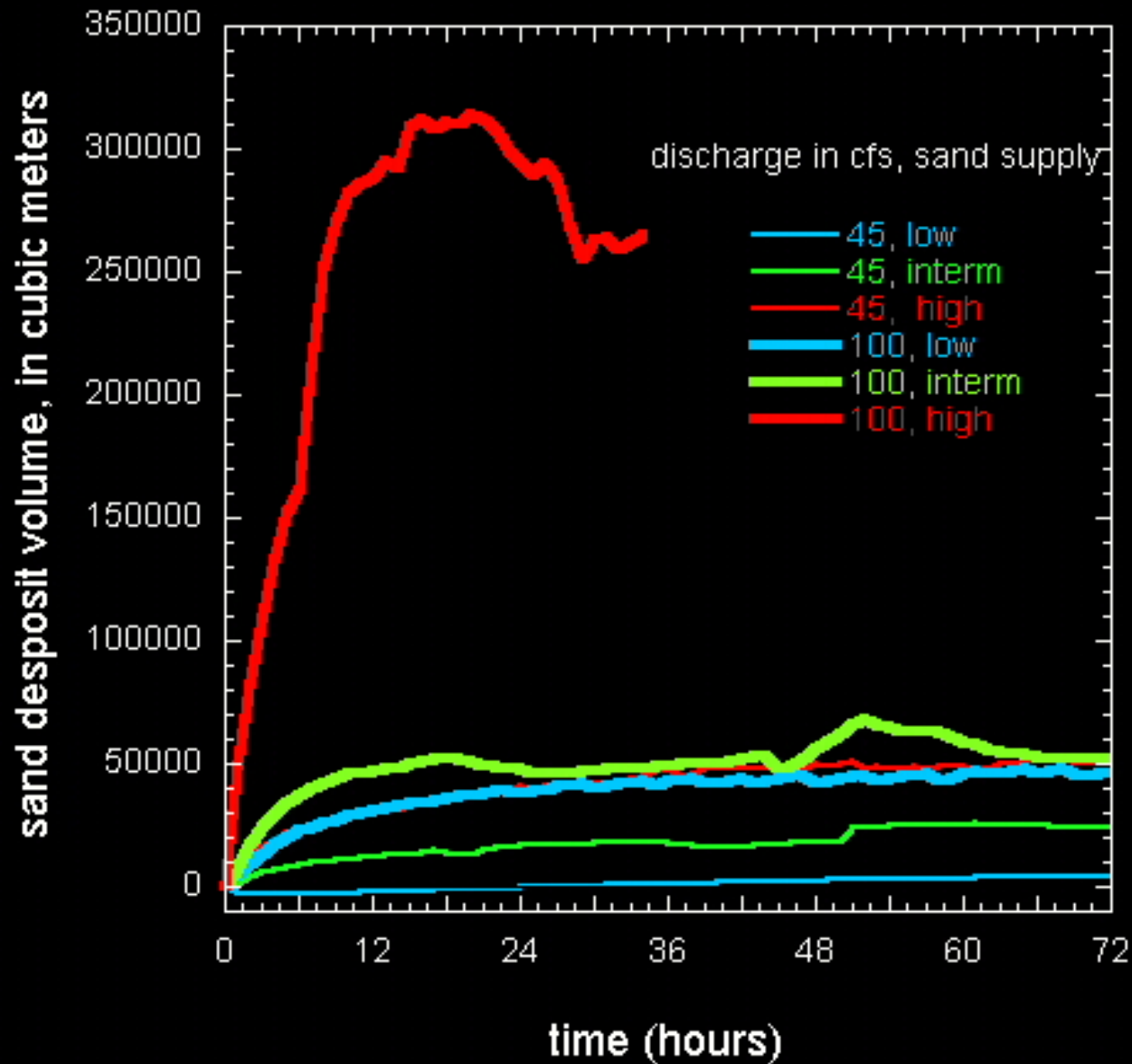


# Upper Unkar

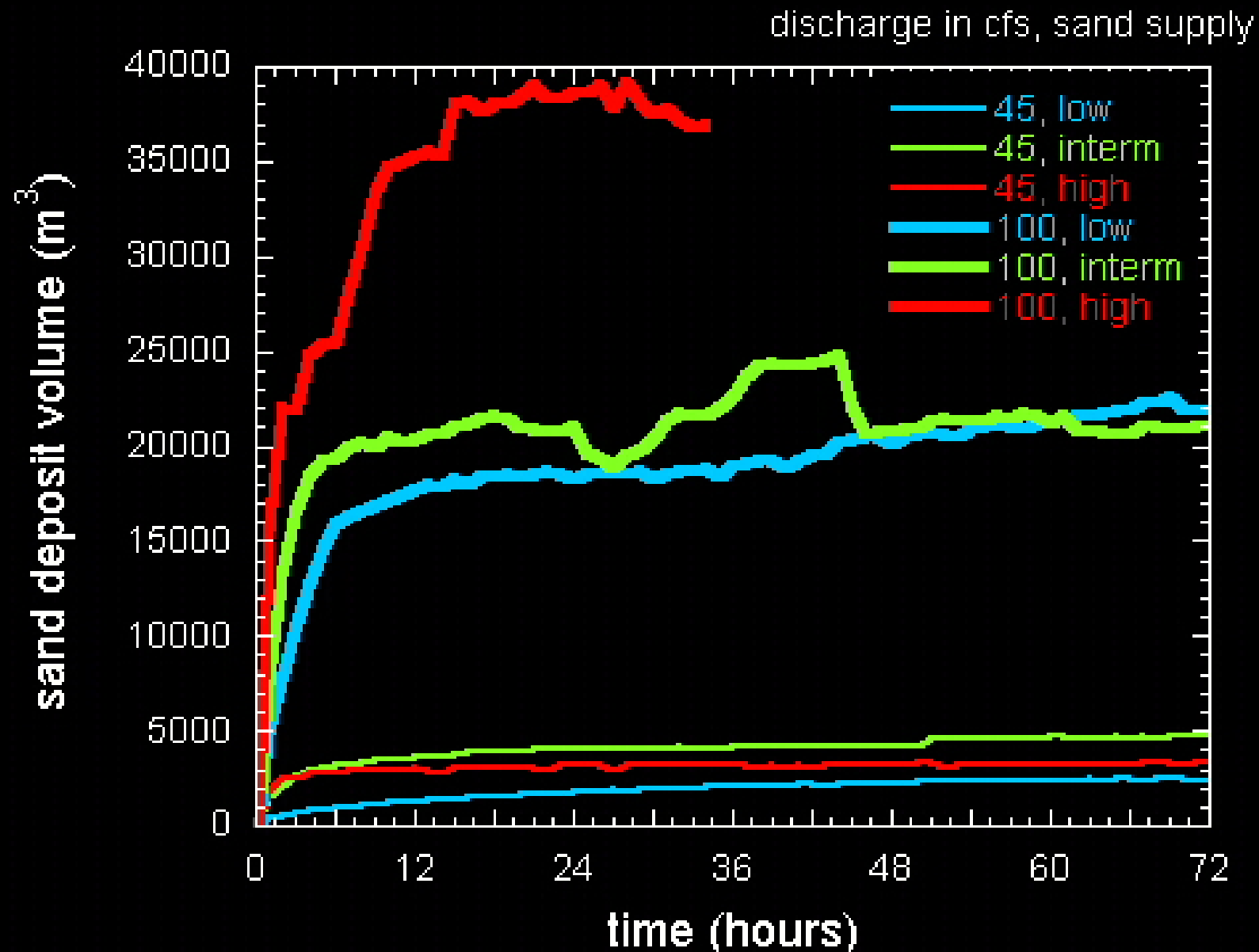
bed elevation (m)



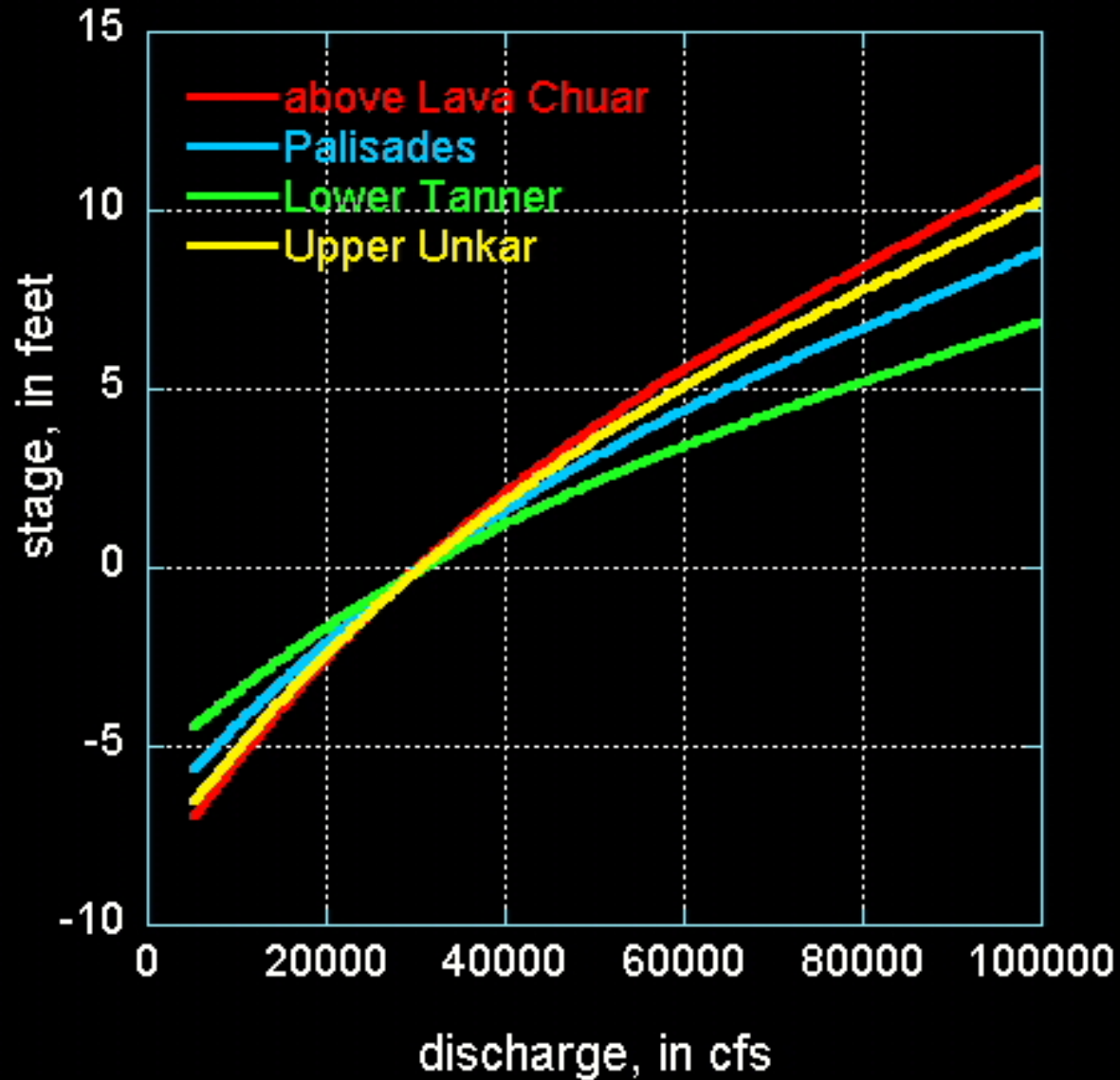
# Upper Unkar total sand deposition



# Upper Unkar deposits above 25k cfs stage



# Stage-discharge relations in the four study reaches



# Conclusions

- High discharge releases are more effective at generating significant deposition
- High flows are most effective during the first 2 days
- Deposition sensitive to sand supply
- Response of recirculation zones consistent; channel margins are variable
- Infilling of gullies limited even at high discharges

# Armwavng

- Can restoration of sand deposits help heal gullies?
- Deposits too low and easily erodible to cause backfilling
- Some existing gullies too entrenched for eolian processes to heal

**Wiele, S.M., and Torizzo, M., 2003, A stage-normalized function for the synthesis of stage-discharge relations for the Colorado River in Grand Canyon, Arizona, USGS Water-Resources Investigations Report 03-4037. Online at <http://az.water.usgs.gov/pubs/03-4037intro.html>**

**Wiele, S.M. and Torizzo, M., Modeling of sand deposition in archeologically significant reaches of the Colorado River in Grand Canyon, USA, Bates, P., Lane, S., and Ferguson, R. (eds.) Environmental Computational Fluid Dynamics, in press.**