

Geodynamics of large lakes: Bonneville and Lahontan

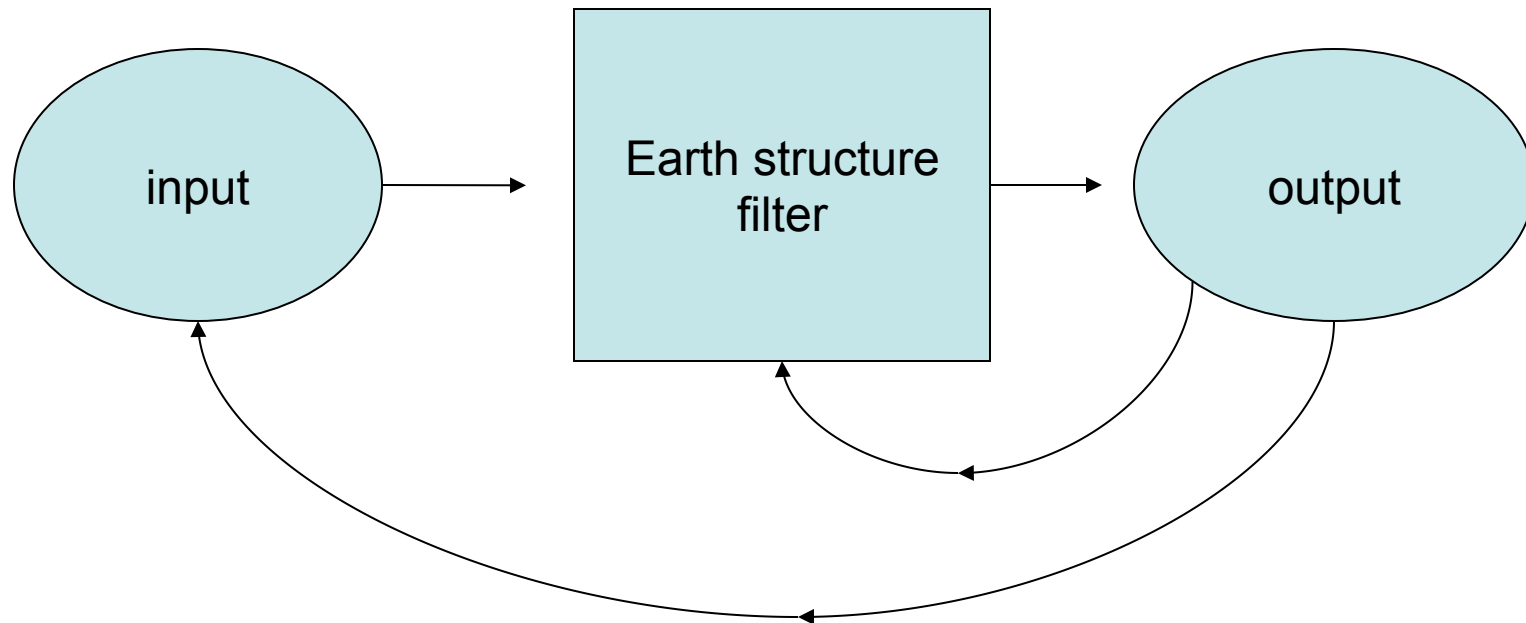
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Jet Propulsion Laboratory

basic problem

- on time-scales shorter than a day
 - Earth behaves like an elastic solid
 - from the surface to the core-mantle boundary
- on plate tectonic time-scales (millions of years)
 - Earth behaves like a viscous fluid
 - from the lithosphere on down
- how does that transition occur?

generic forcing model



methods of probing Earth structure

type	input	output	time scale
earthquakes	impulsive displacement	displacement	seconds-days
tides	periodic gravitational potential	displacement, gravity anomaly	hours-weeks
ice sheets	complex vertical load	displacement	10^2 - 10^4 years
large lakes	complex vertical load	displacement	10^2 - 10^4 years

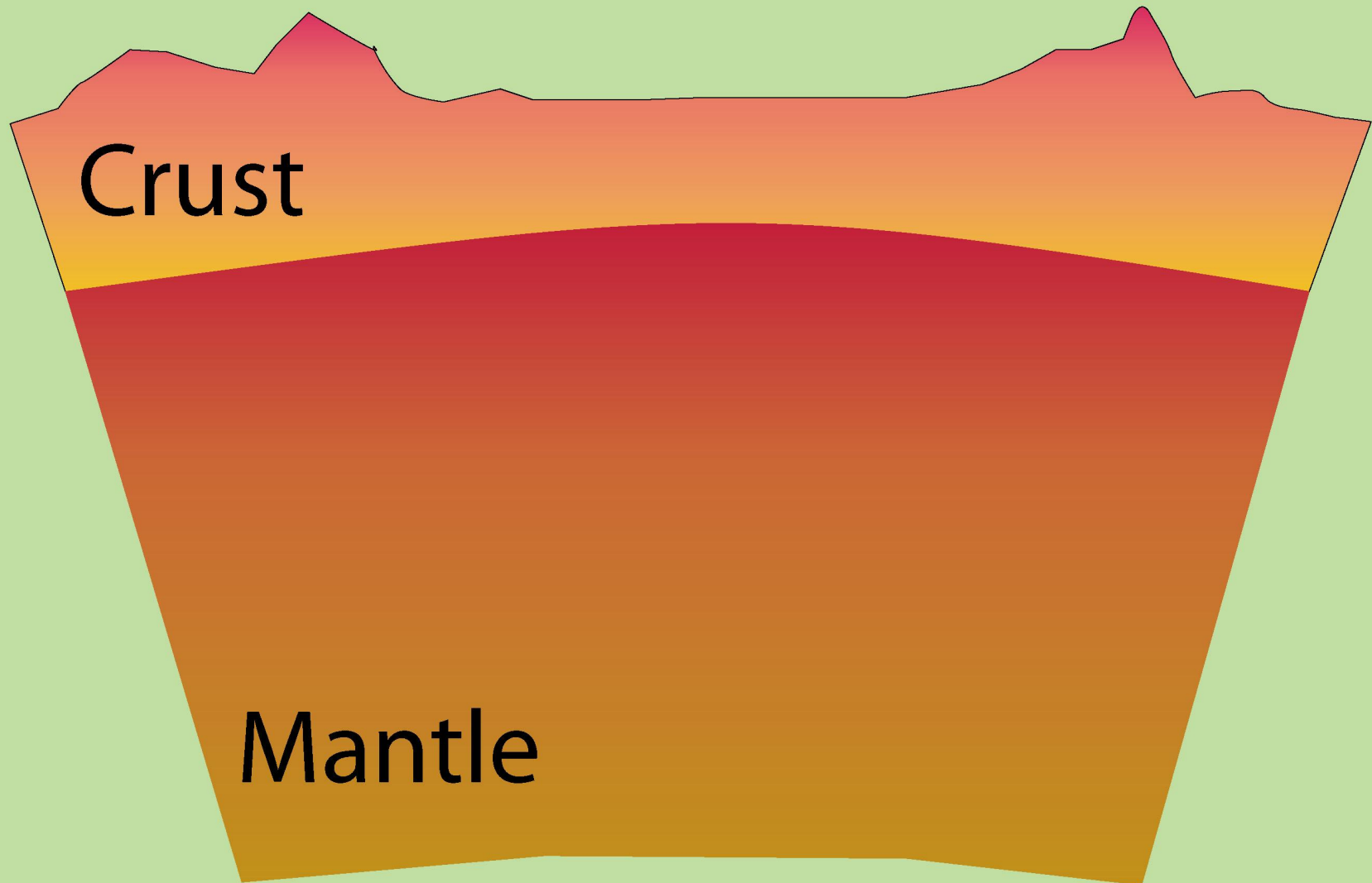
advantages of large lakes

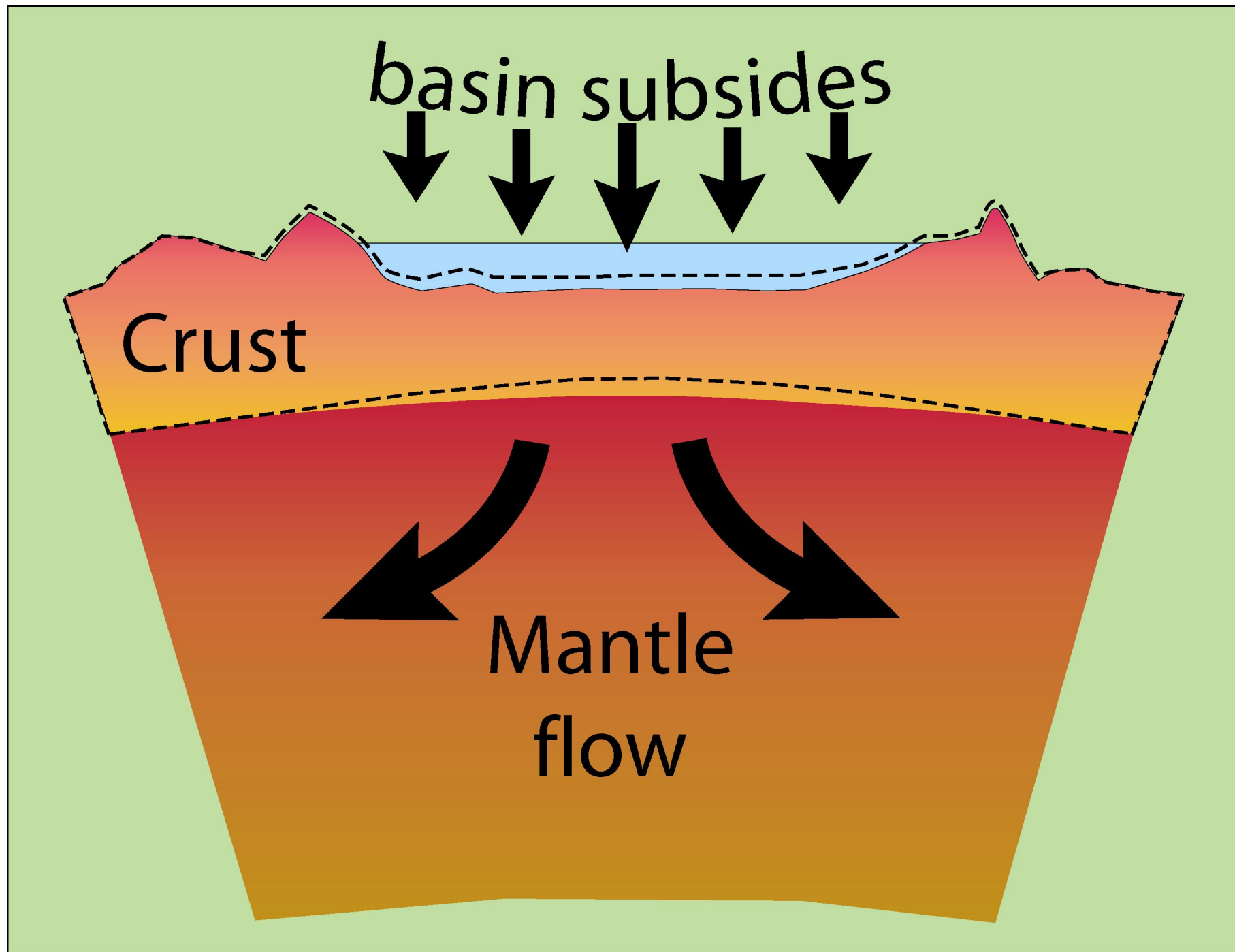
- significant vertical deflection
 - produced via loading
 - recorded in shoreline elevations
- complex load
 - spatial complexity
 - temporal complexity
- temporal record
 - sedimentary layers
 - less destructive than glaciers

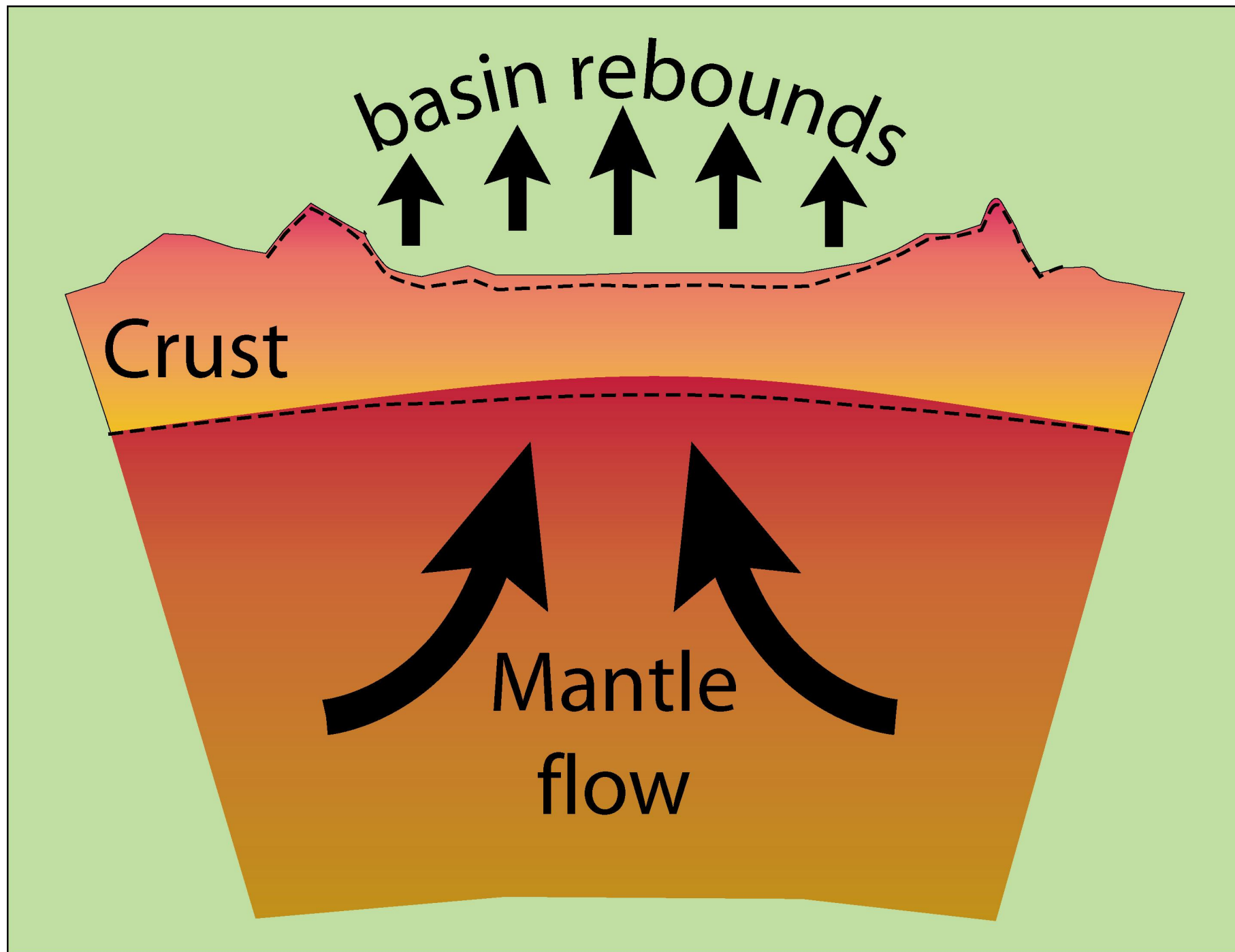
more advantages of lakes

- loads are easily reconstructed
 - top surface is level
 - bottom surface is existing topography
- shorelines are often traceable basin-wide
 - decouples spatial and temporal problems
 - internal consistency

A simple model of the Earth....







compare 2 large lakes

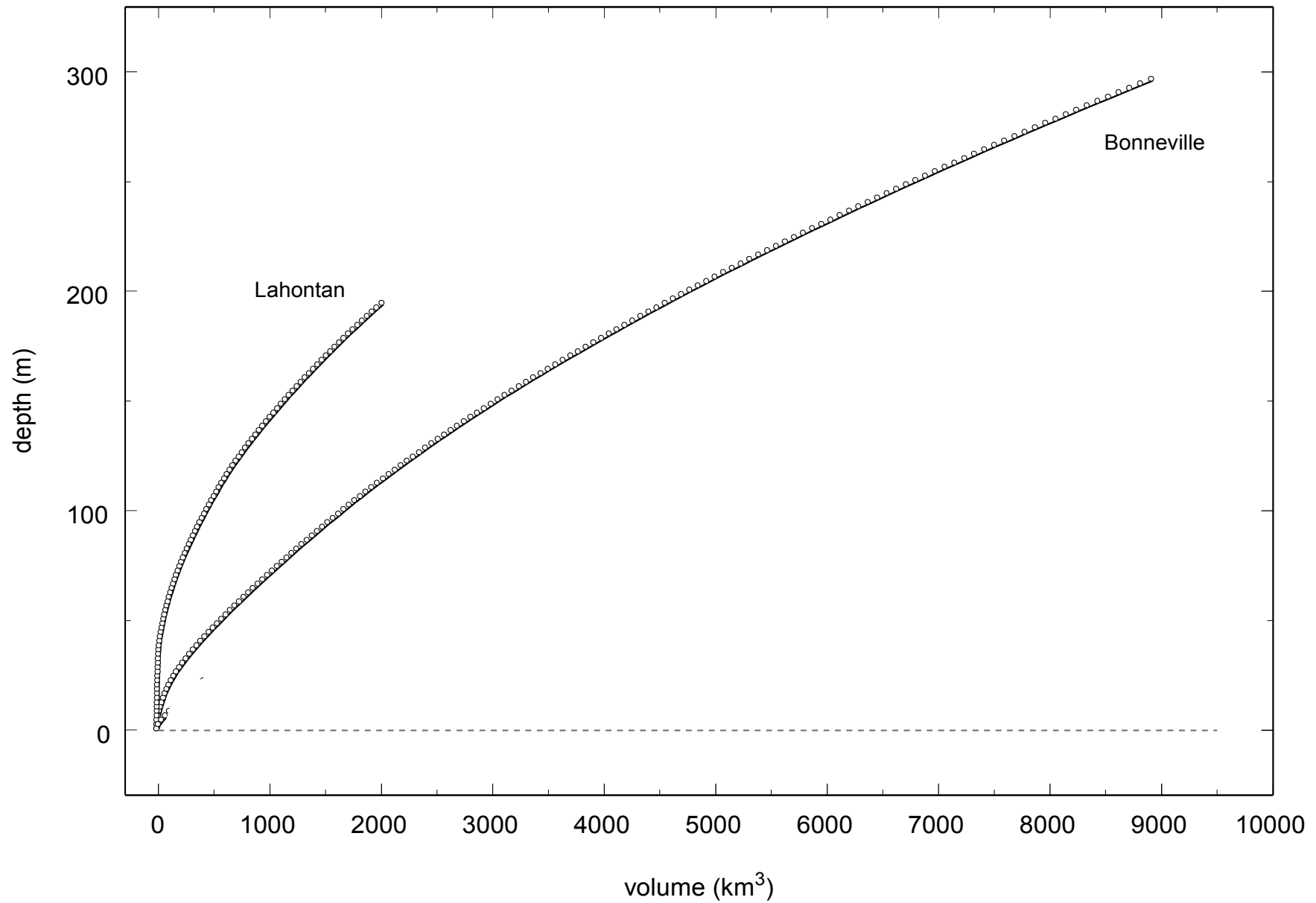
- **Bonneville**

- location: western Utah
- max volume: 9,000 km³ max rebound: 75 m
- max area: 48,000 km² max depth: 330 m

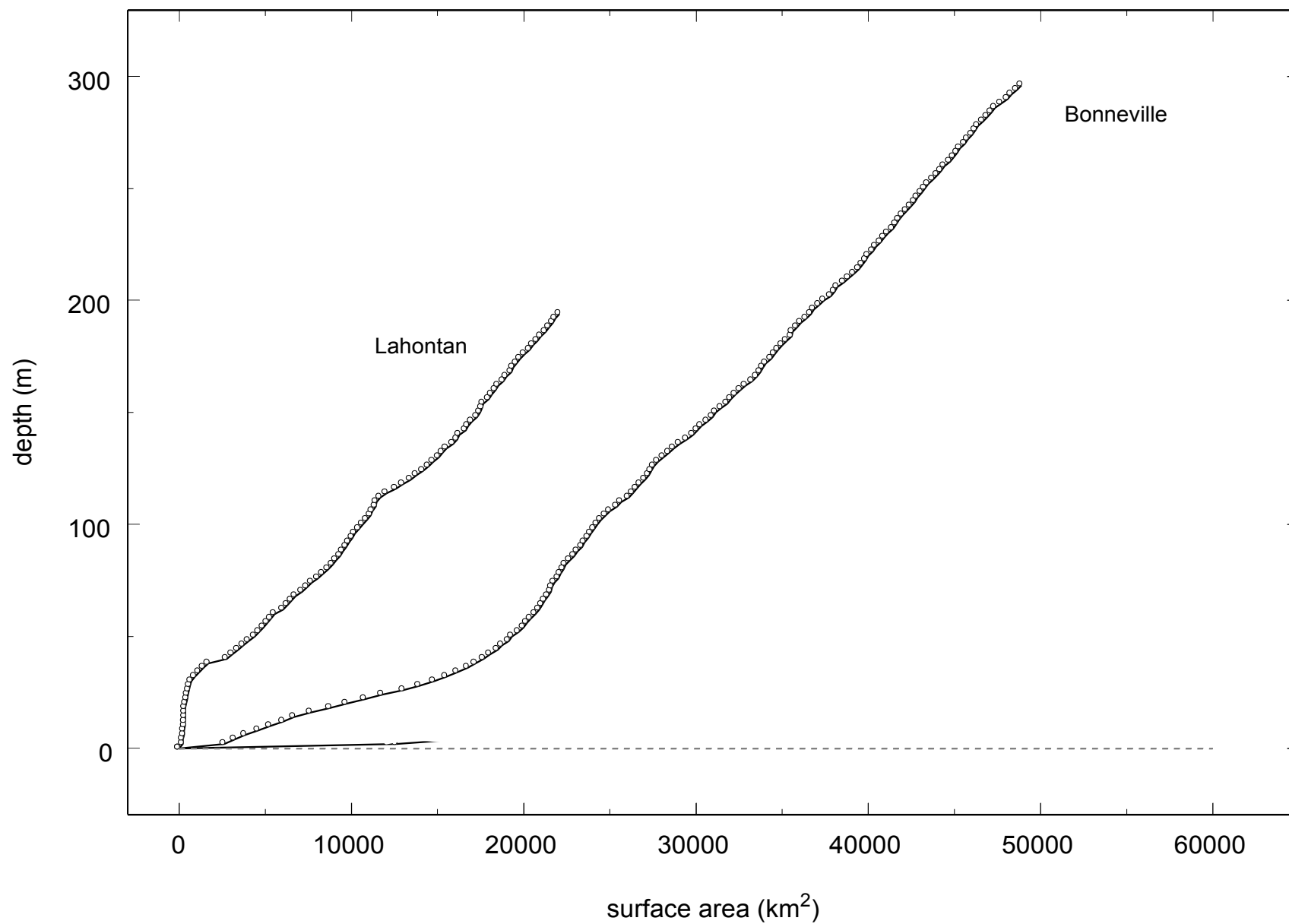
- **Lahontan**

- location: western Nevada
- max volume: 2,000 km³ max rebound: 18 m
- max area: 22,000 km² max depth: 110 m

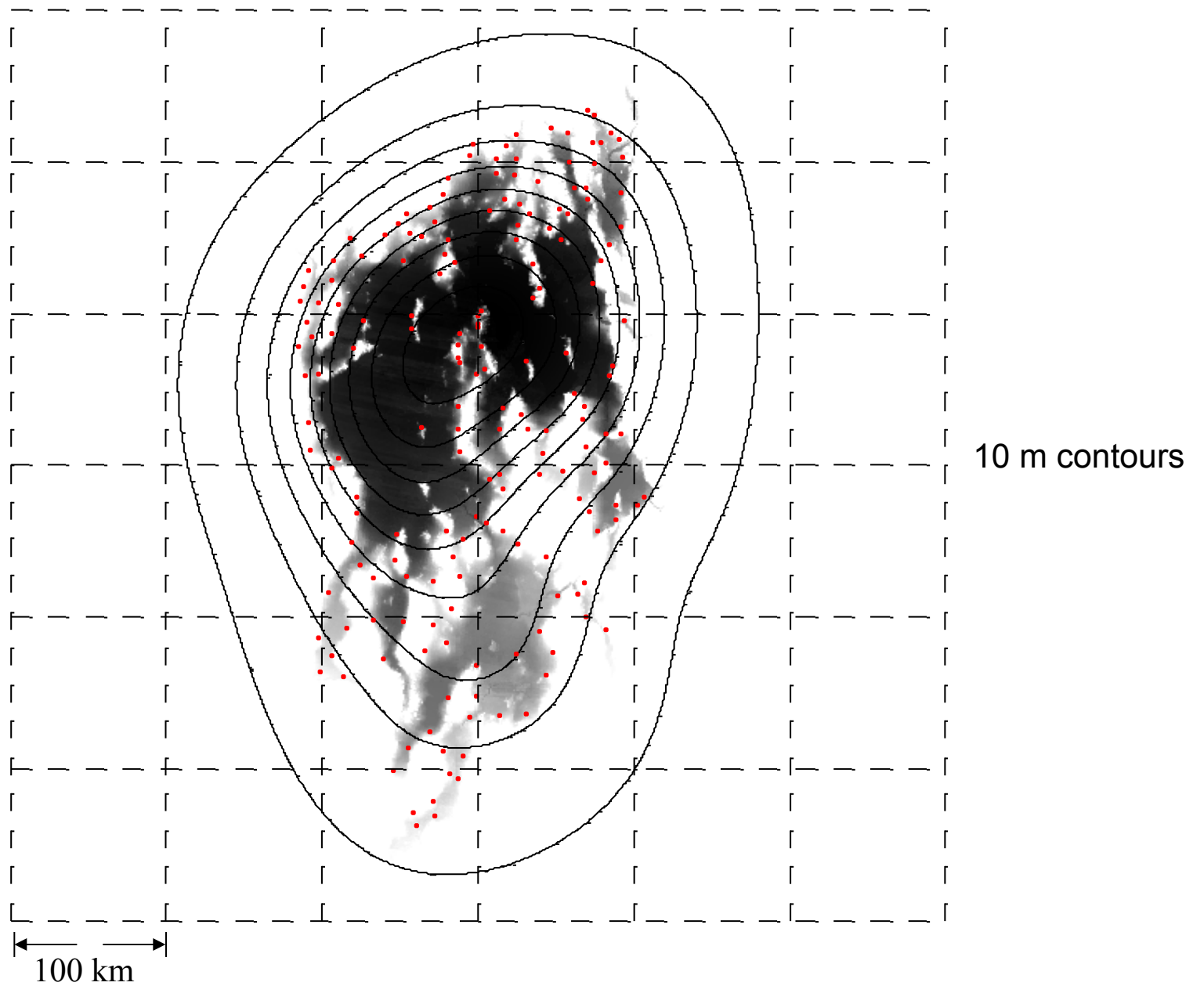
lake volume versus depth



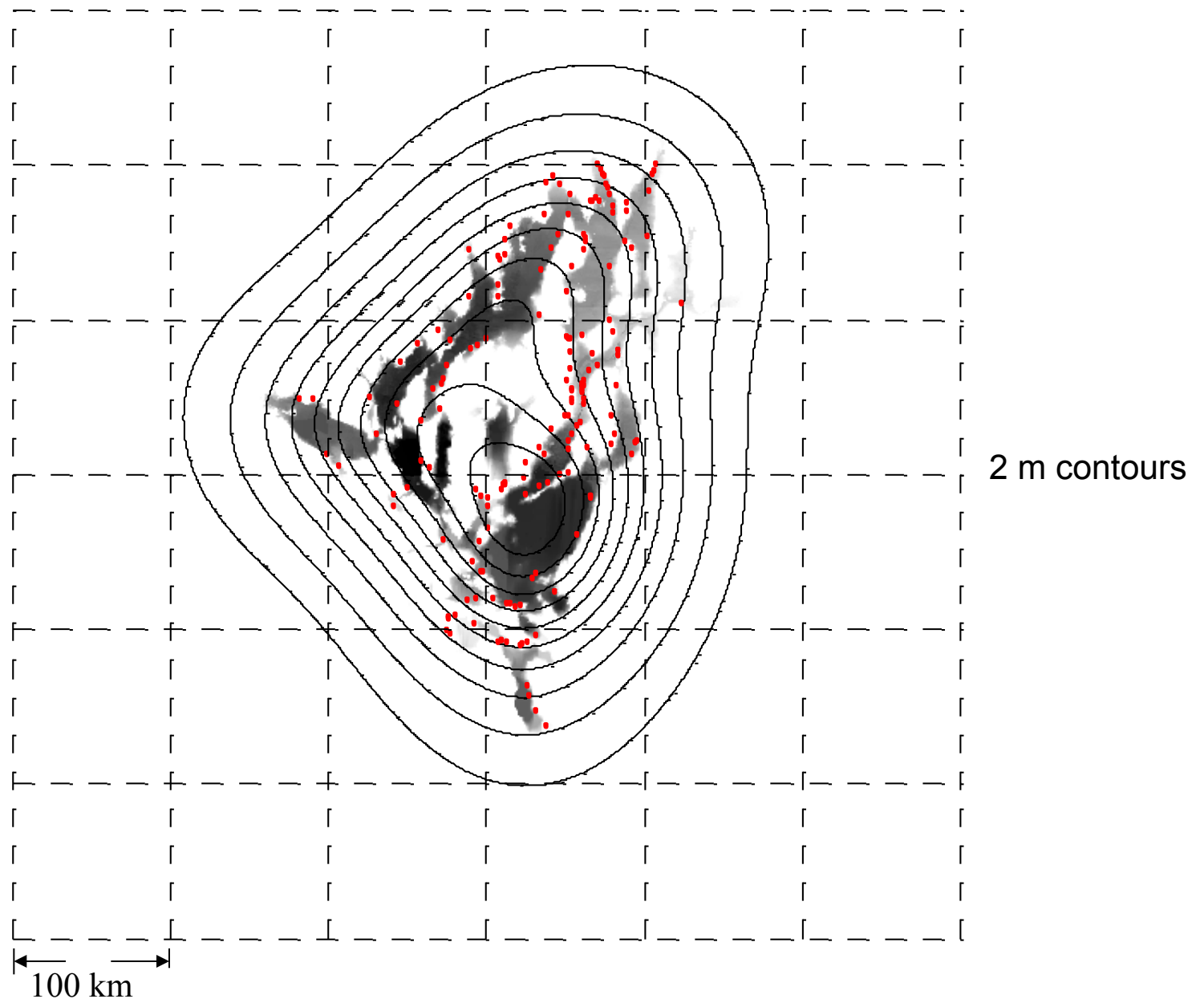
lake surface area versus depth



lake Bonneville load and rebound pattern



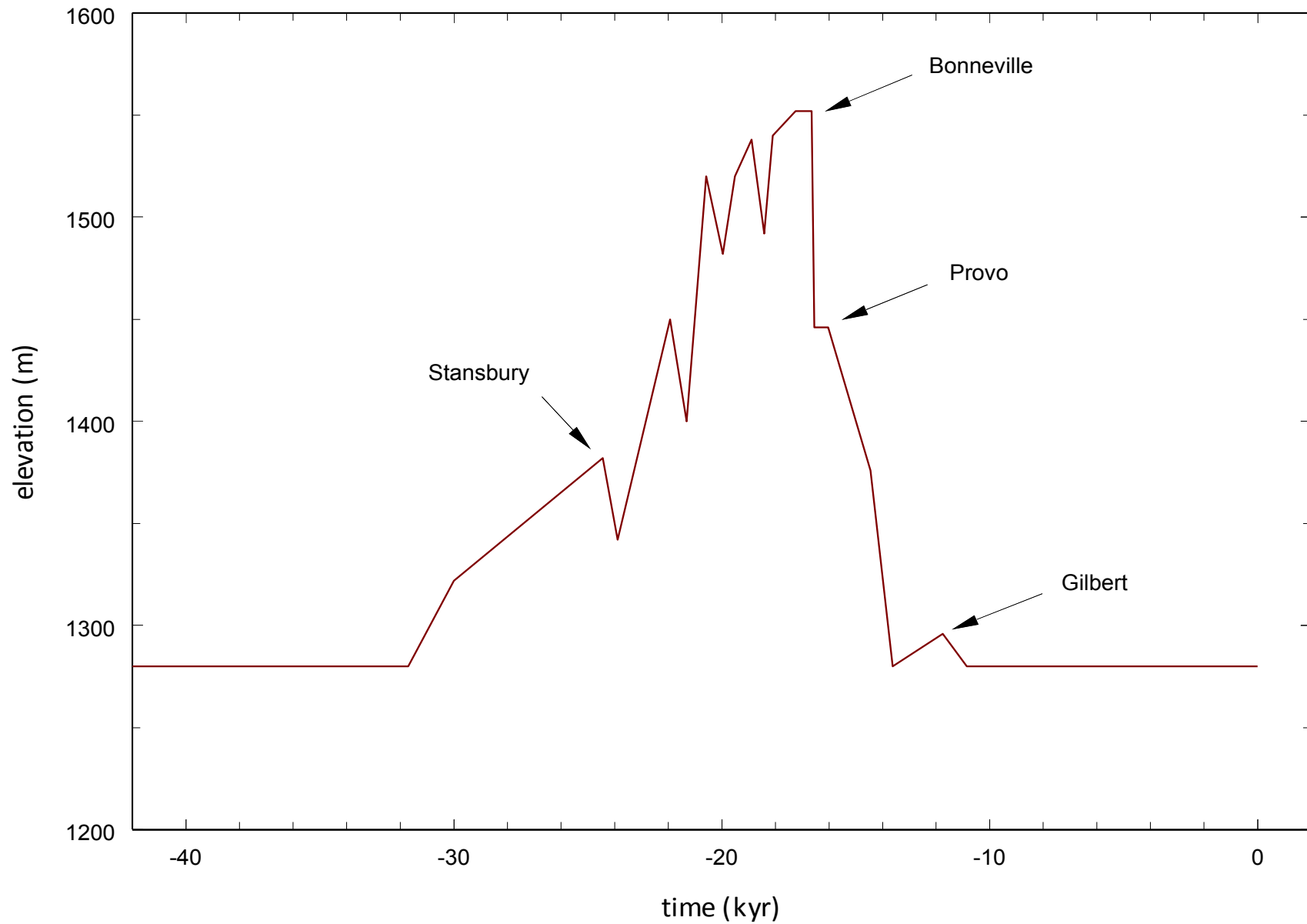
lake Lahontan load and rebound pattern

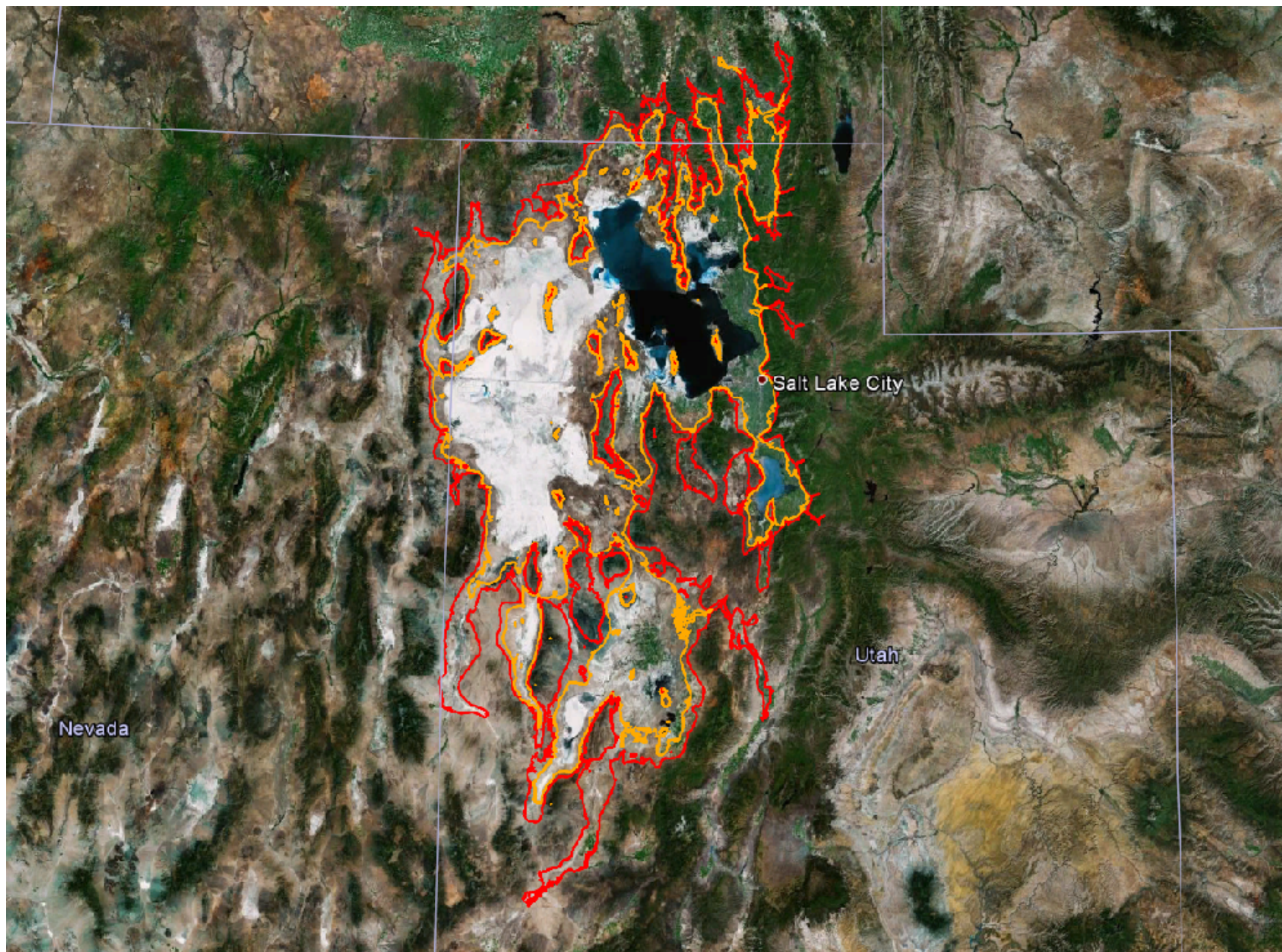


lake Bonneville

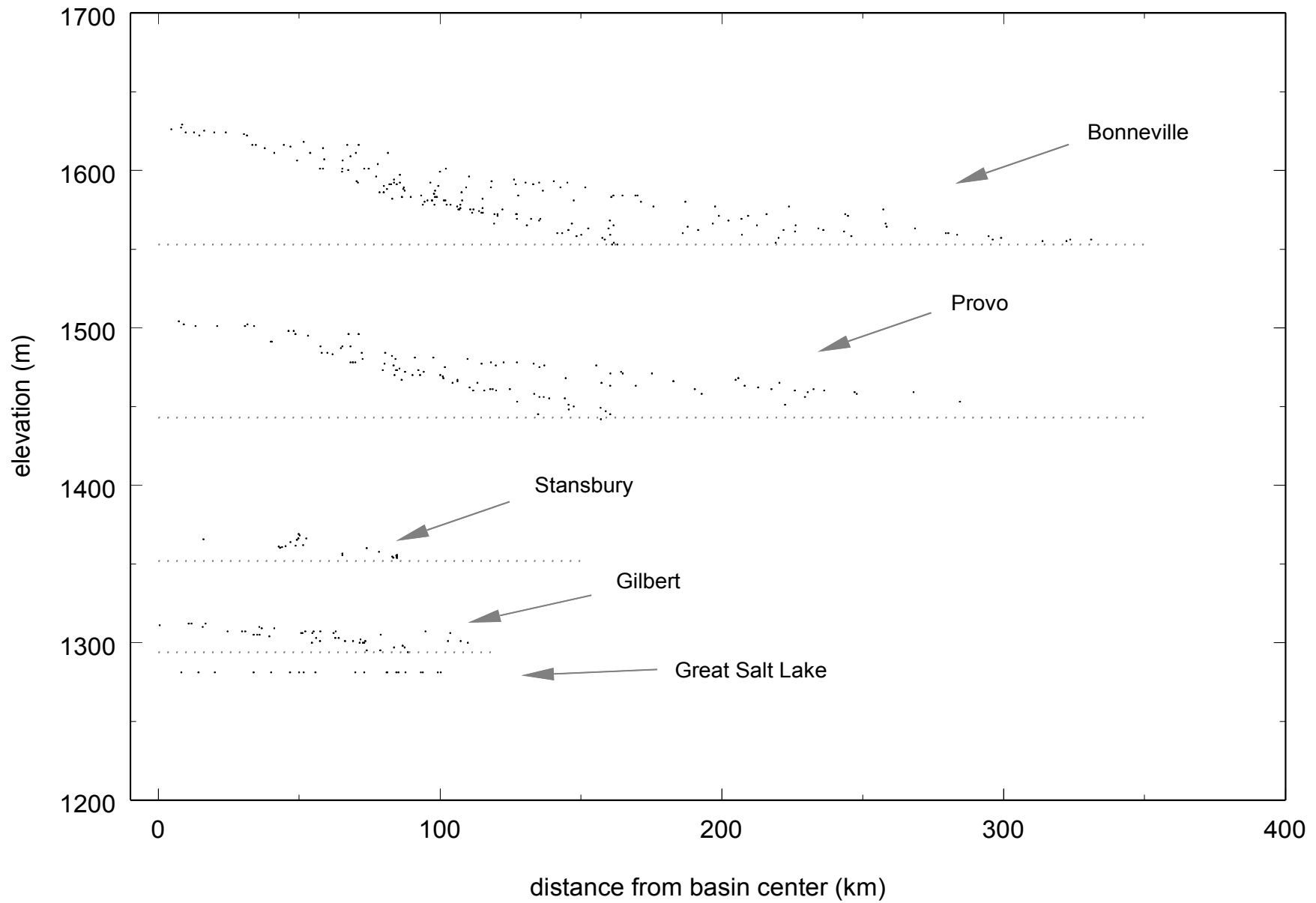
Bonneville Elevation History

Oviatt, Geology, 25, 155-158, 1997.

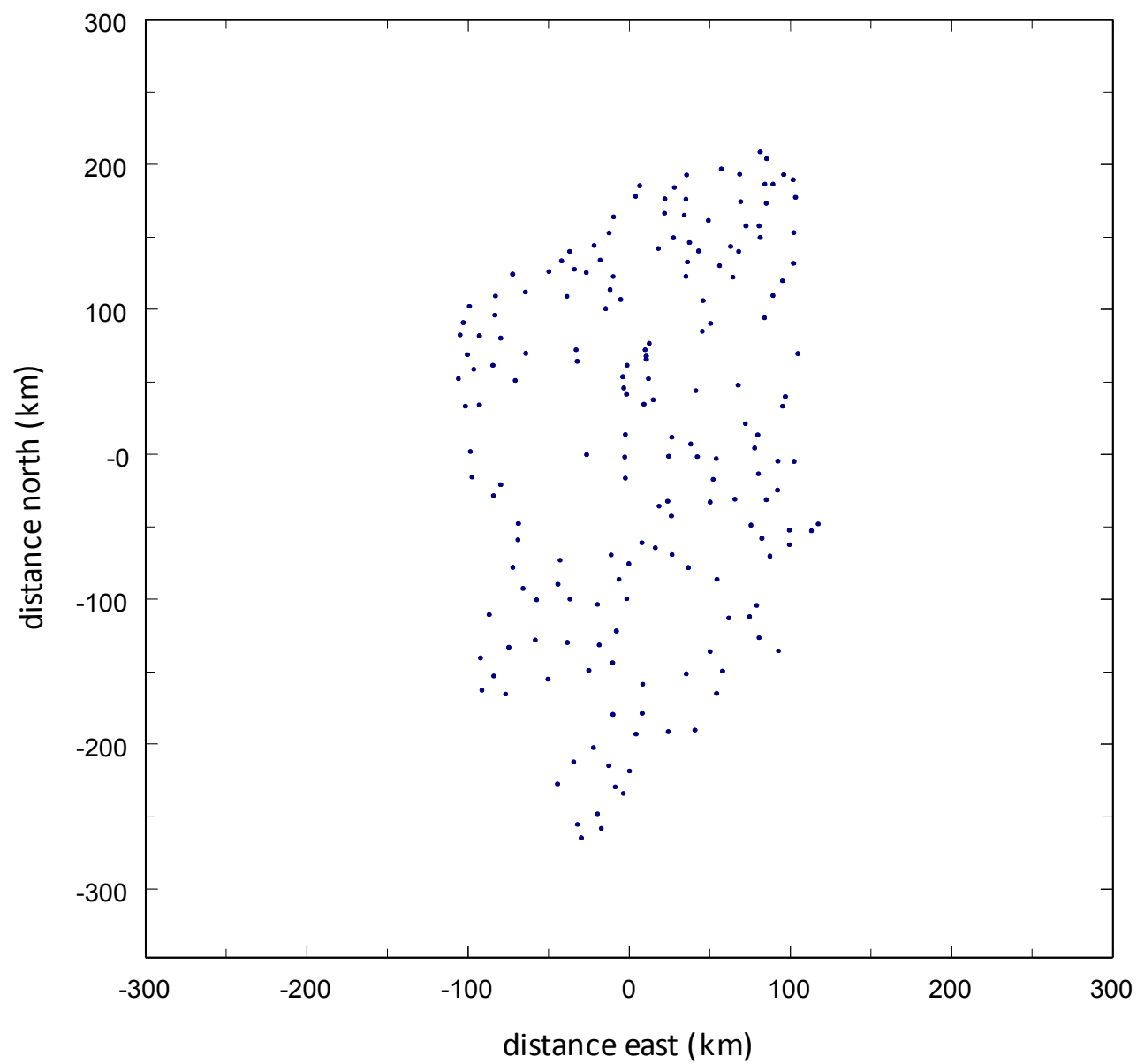




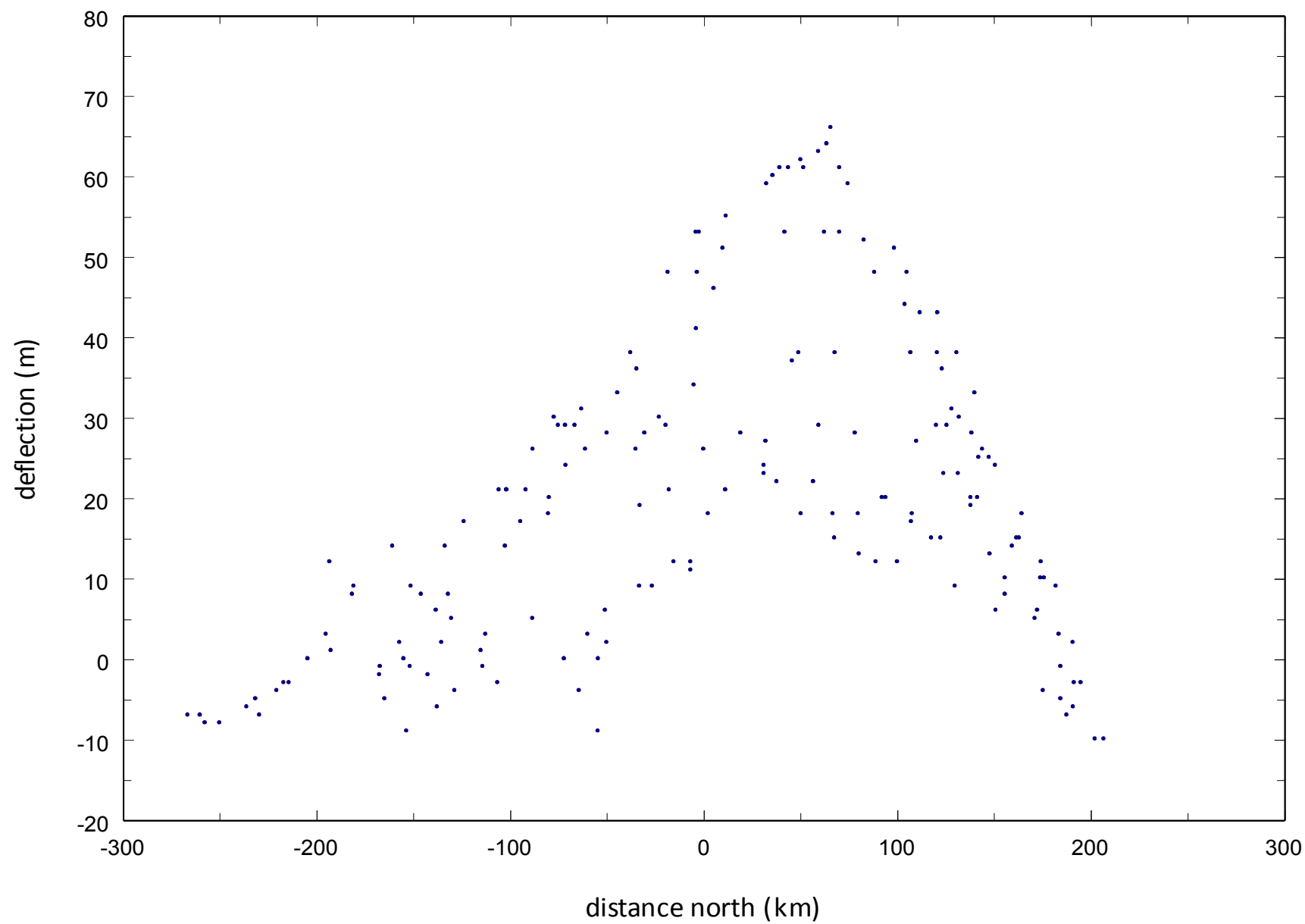
Bonneville basin shoreline elevations



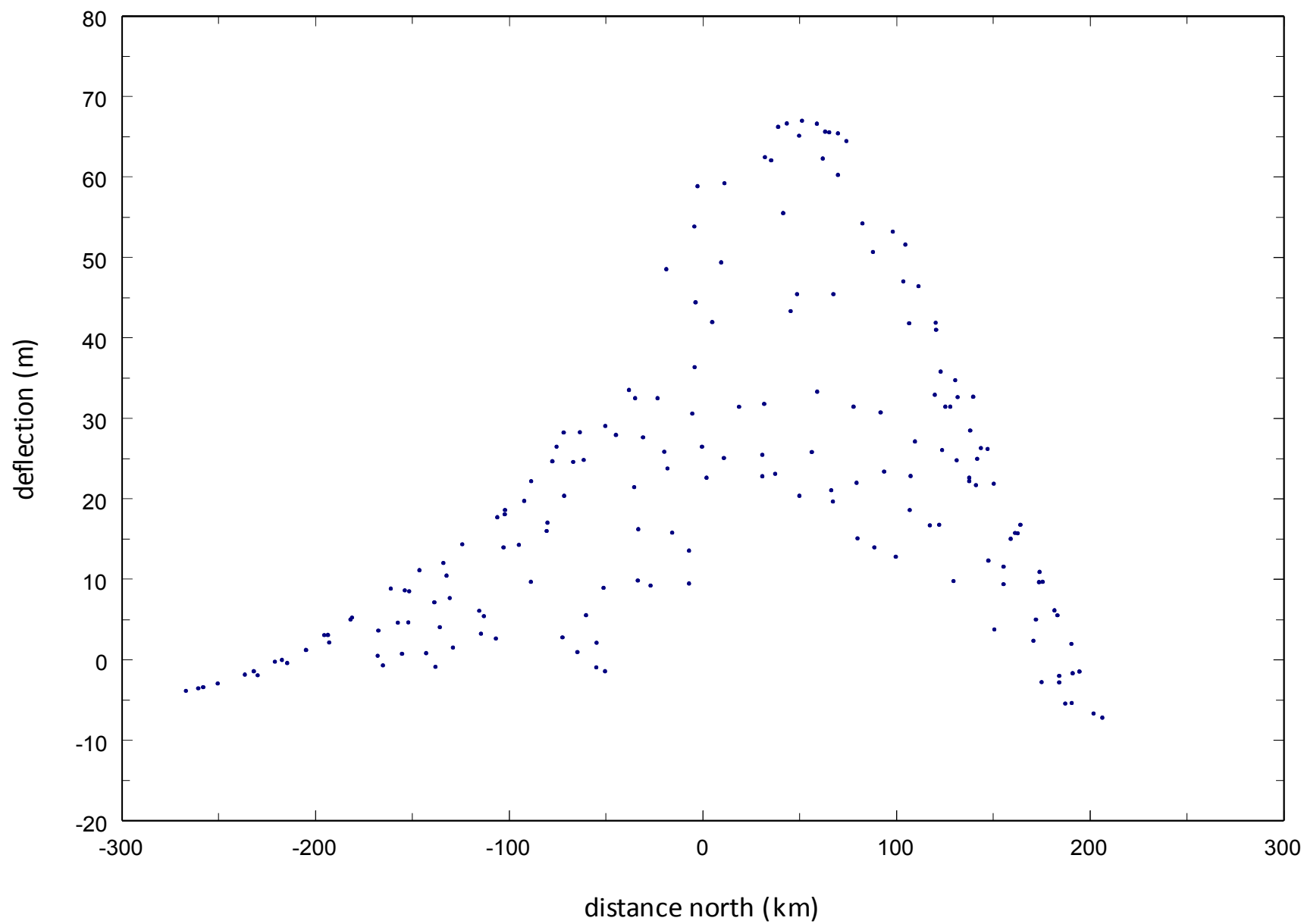
Bonneville: observation sites



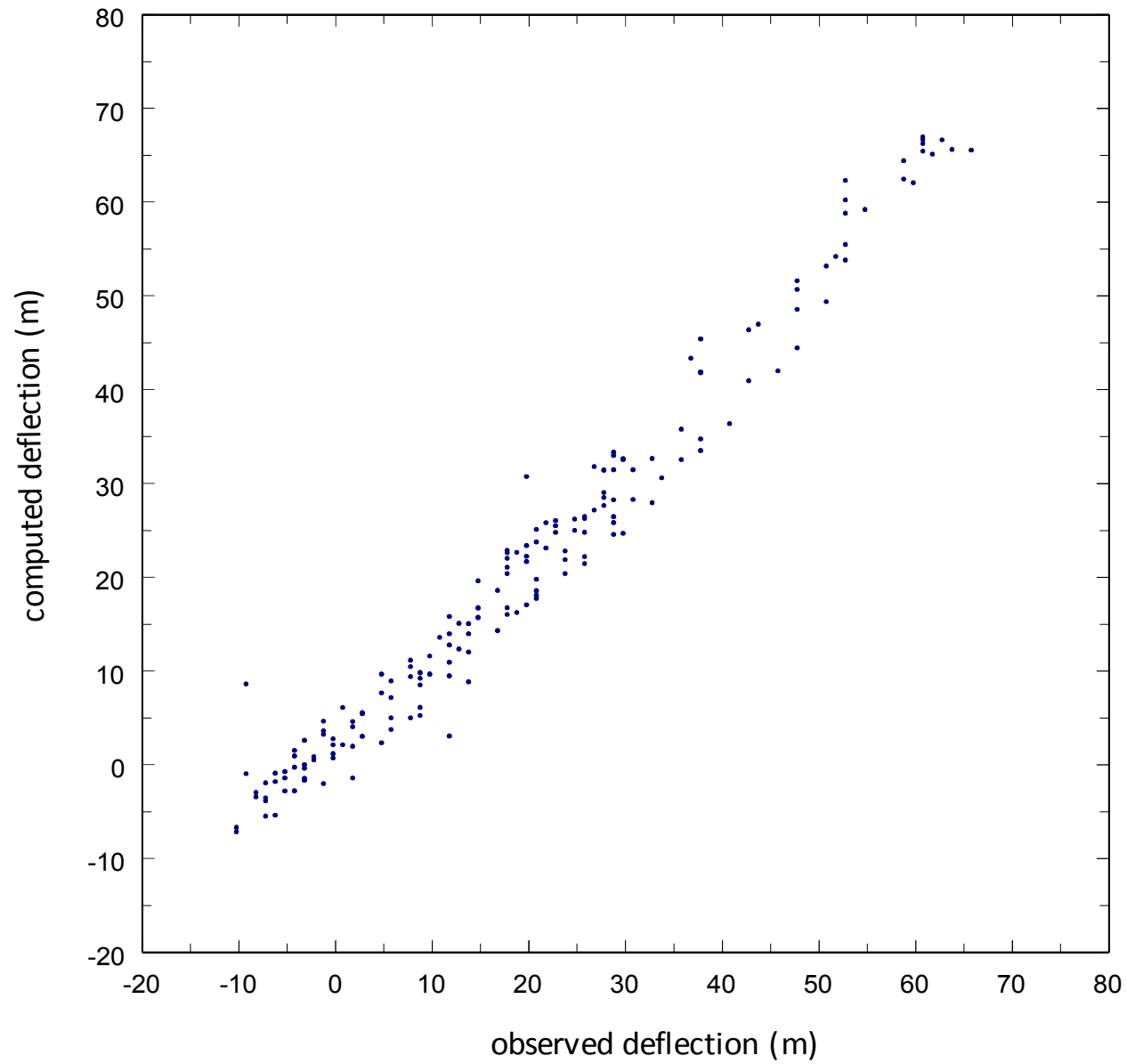
Bonneville: observed deflection



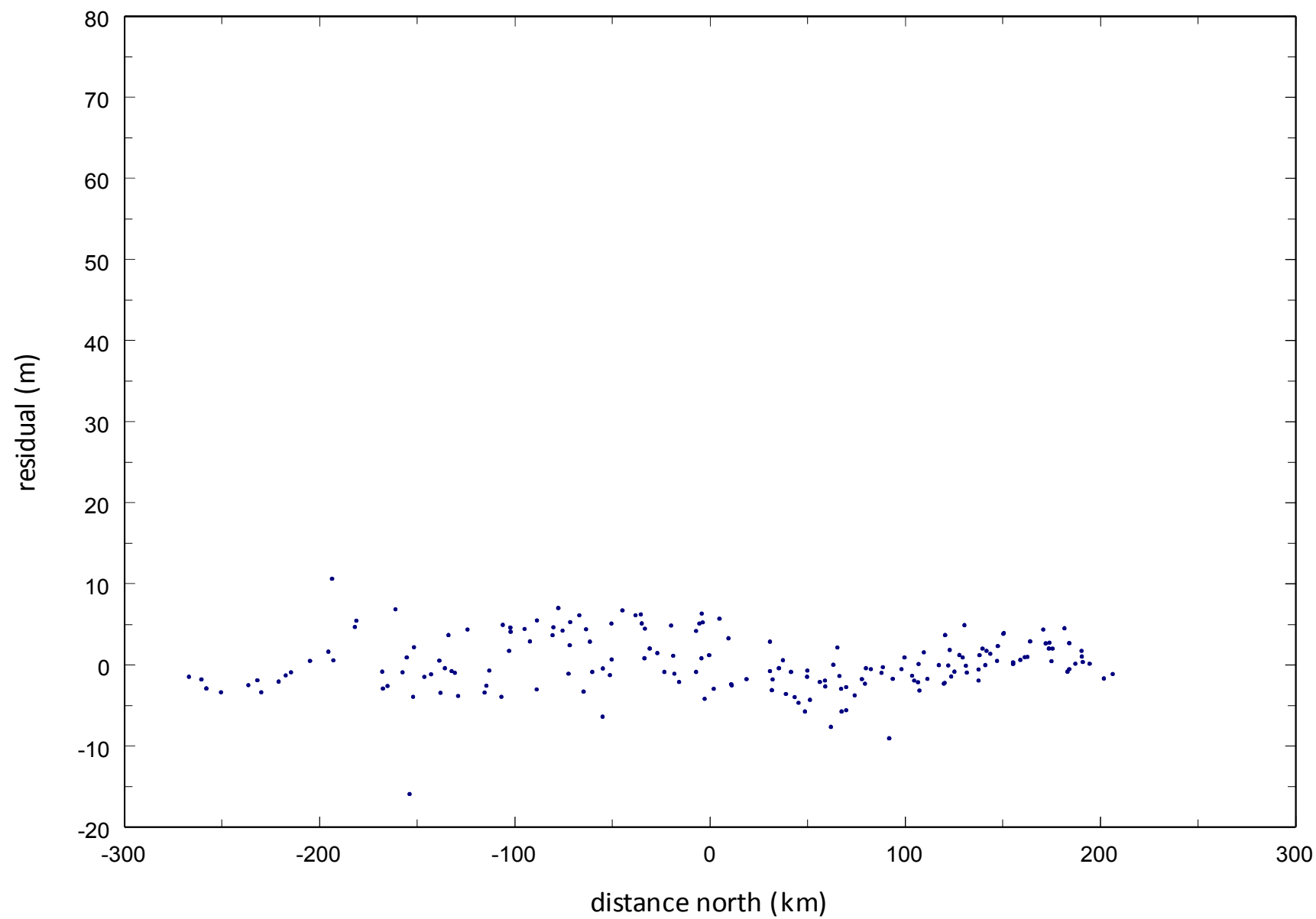
Bonneville: computed deflection



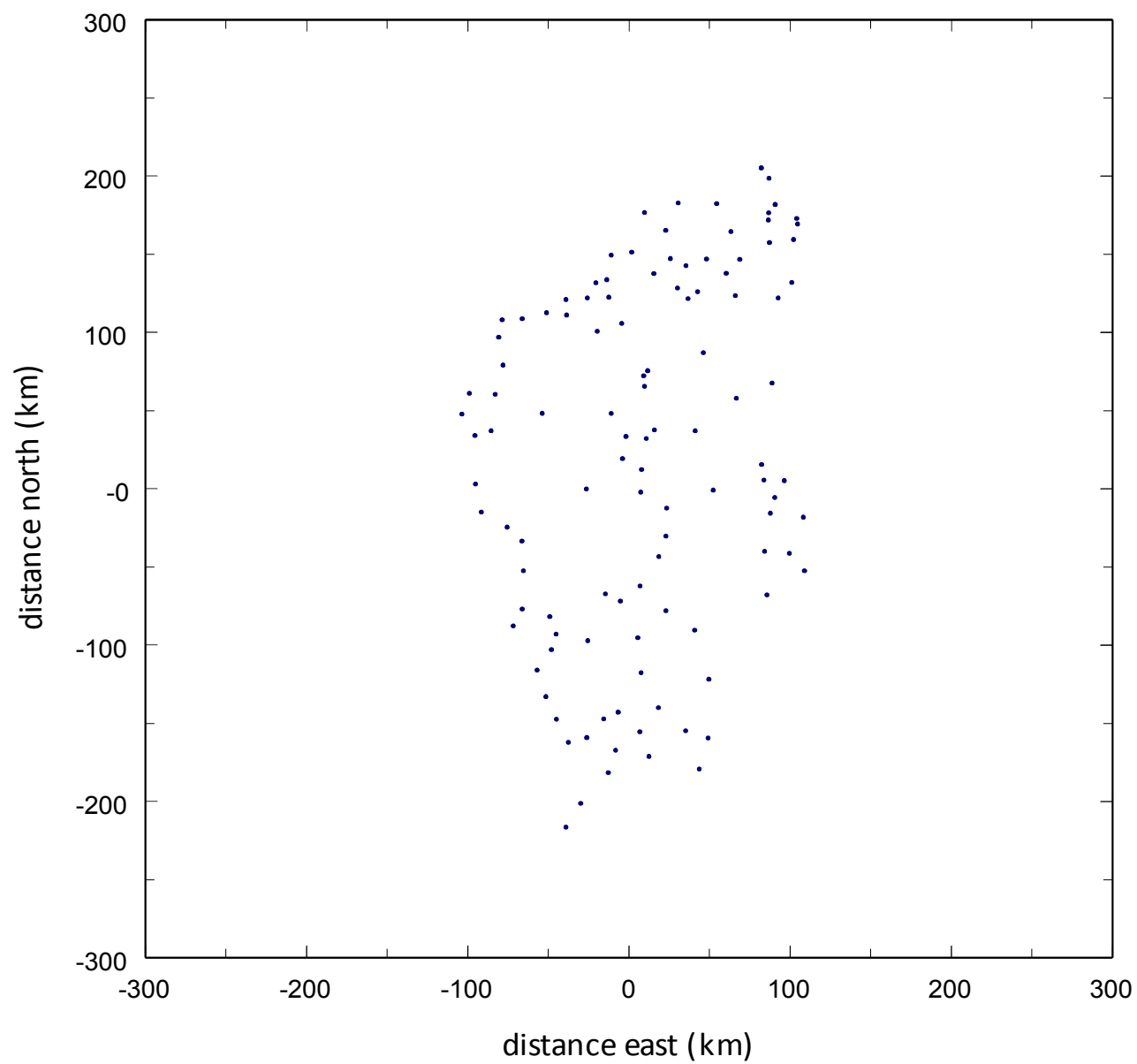
Bonneville: observed vs computed



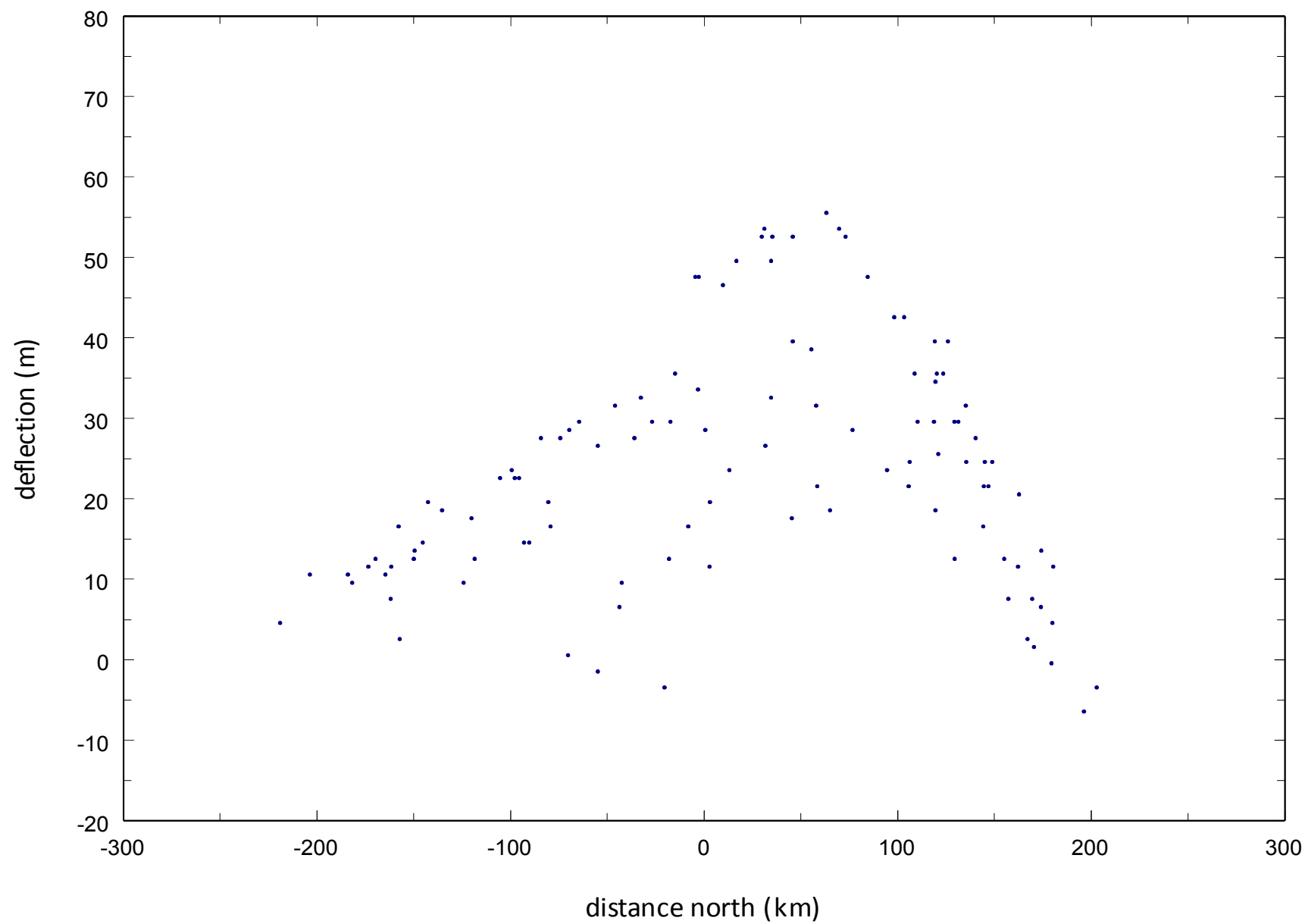
Bonneville: residuals



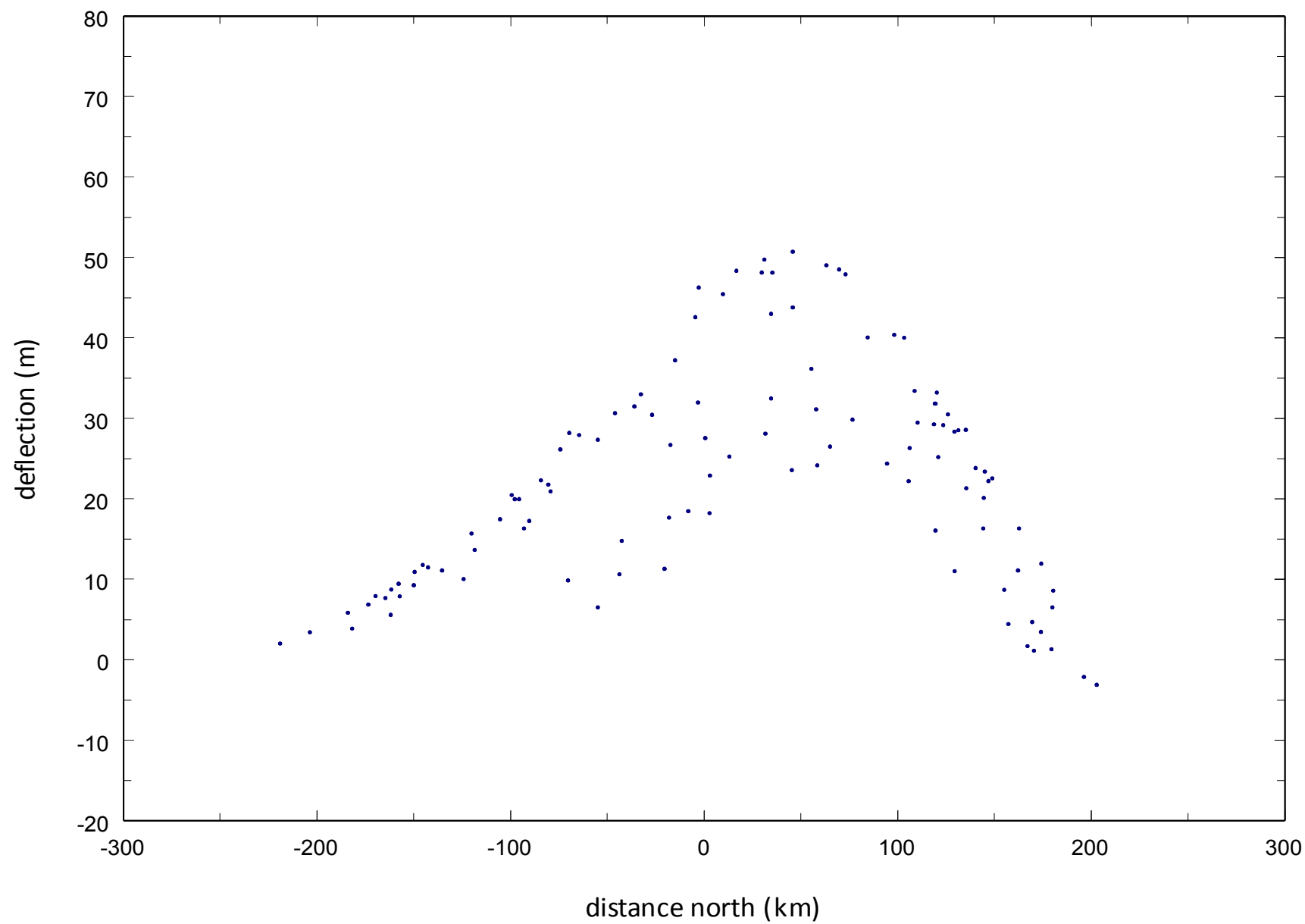
Provo: observation sites



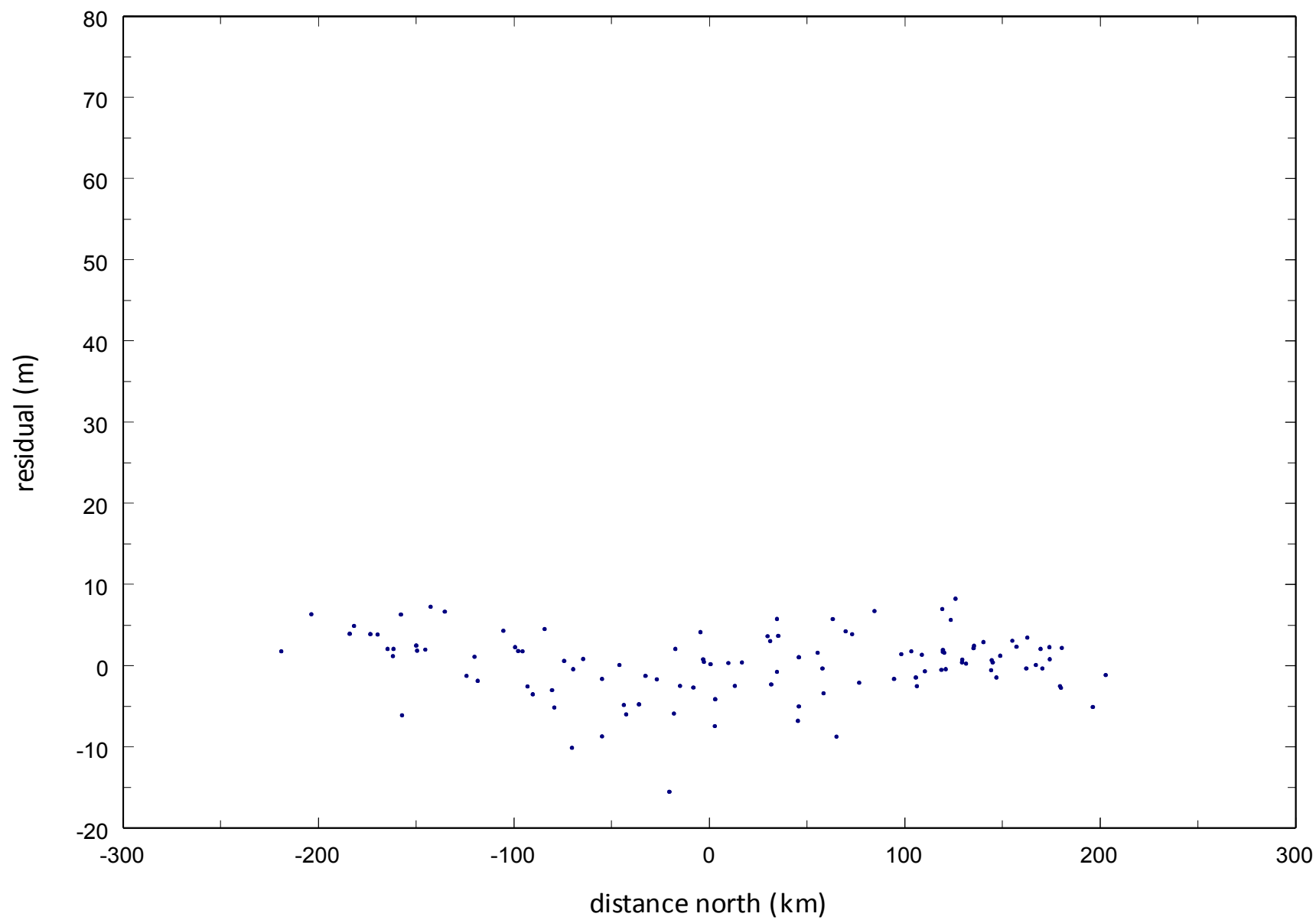
Provo: observed deflection



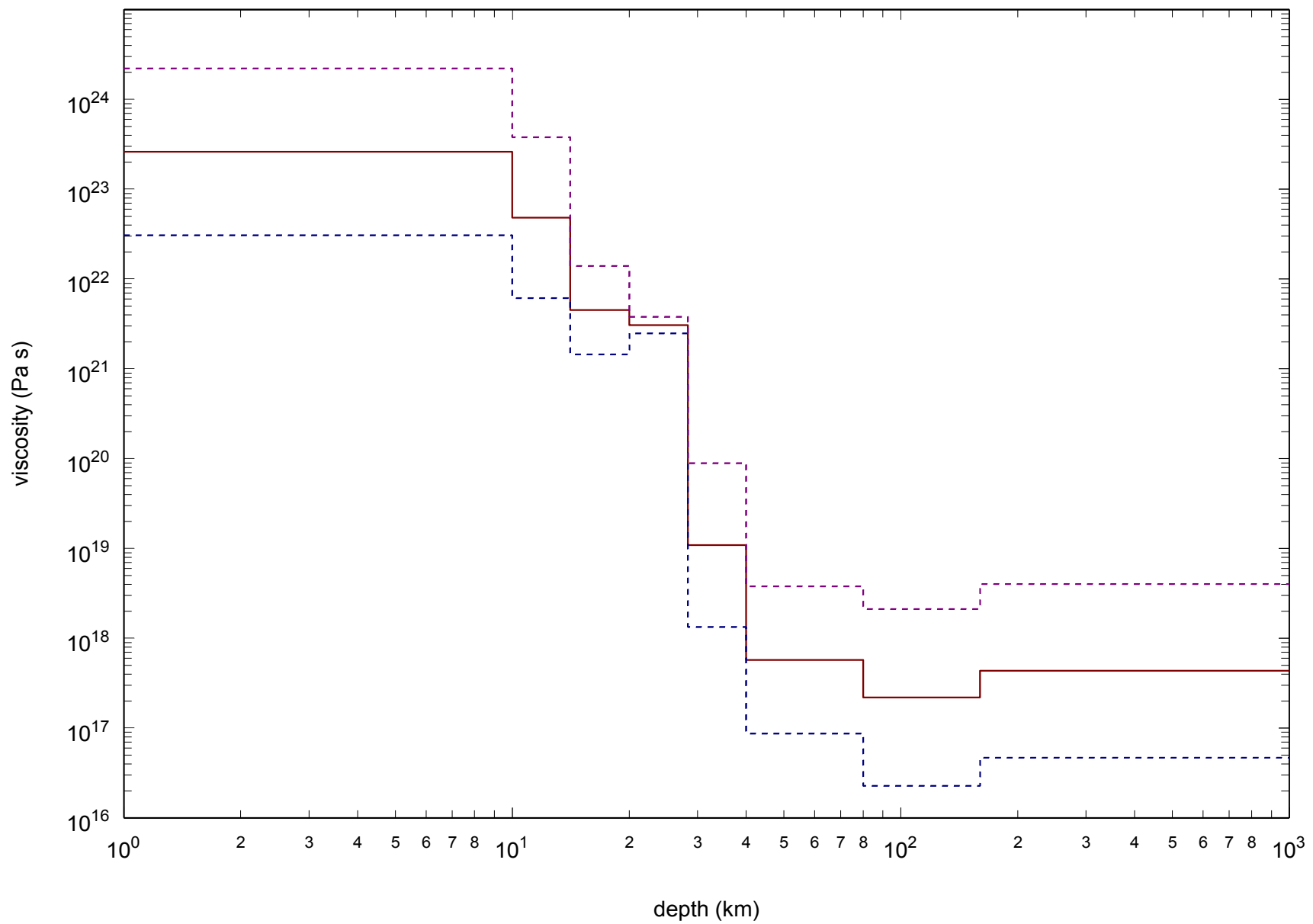
Provo: computed deflection



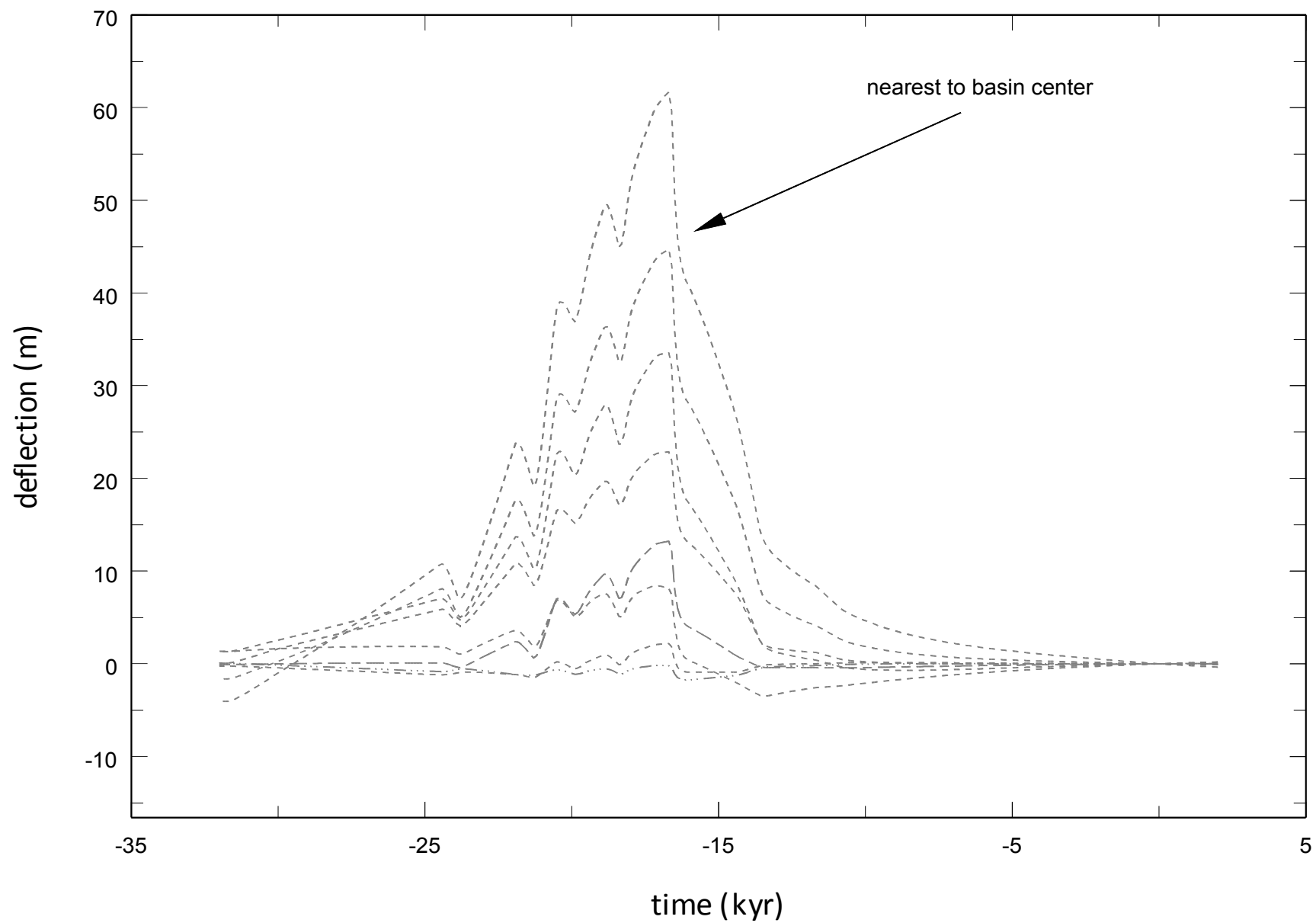
Provo: residuals



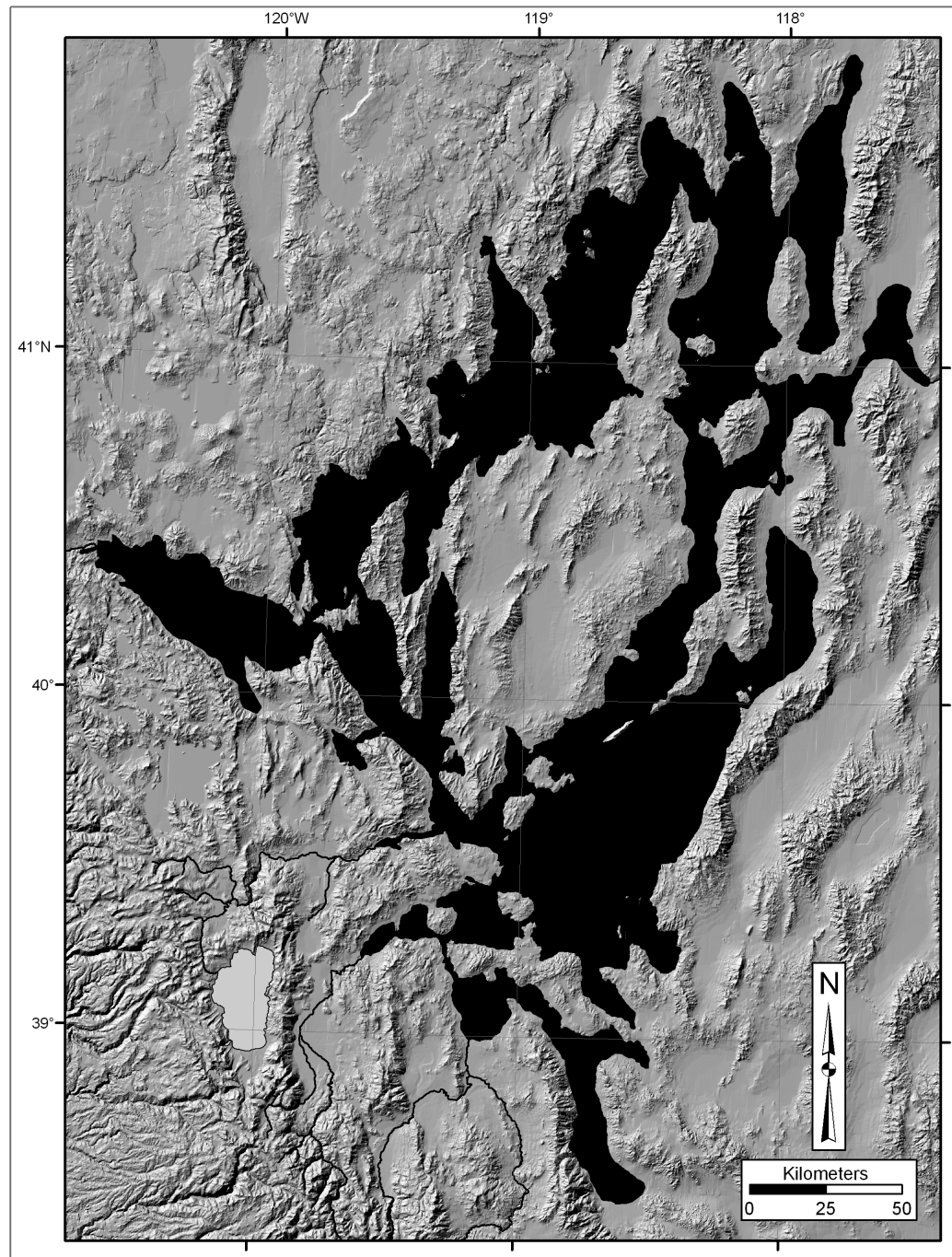
Bonneville basin viscosity model

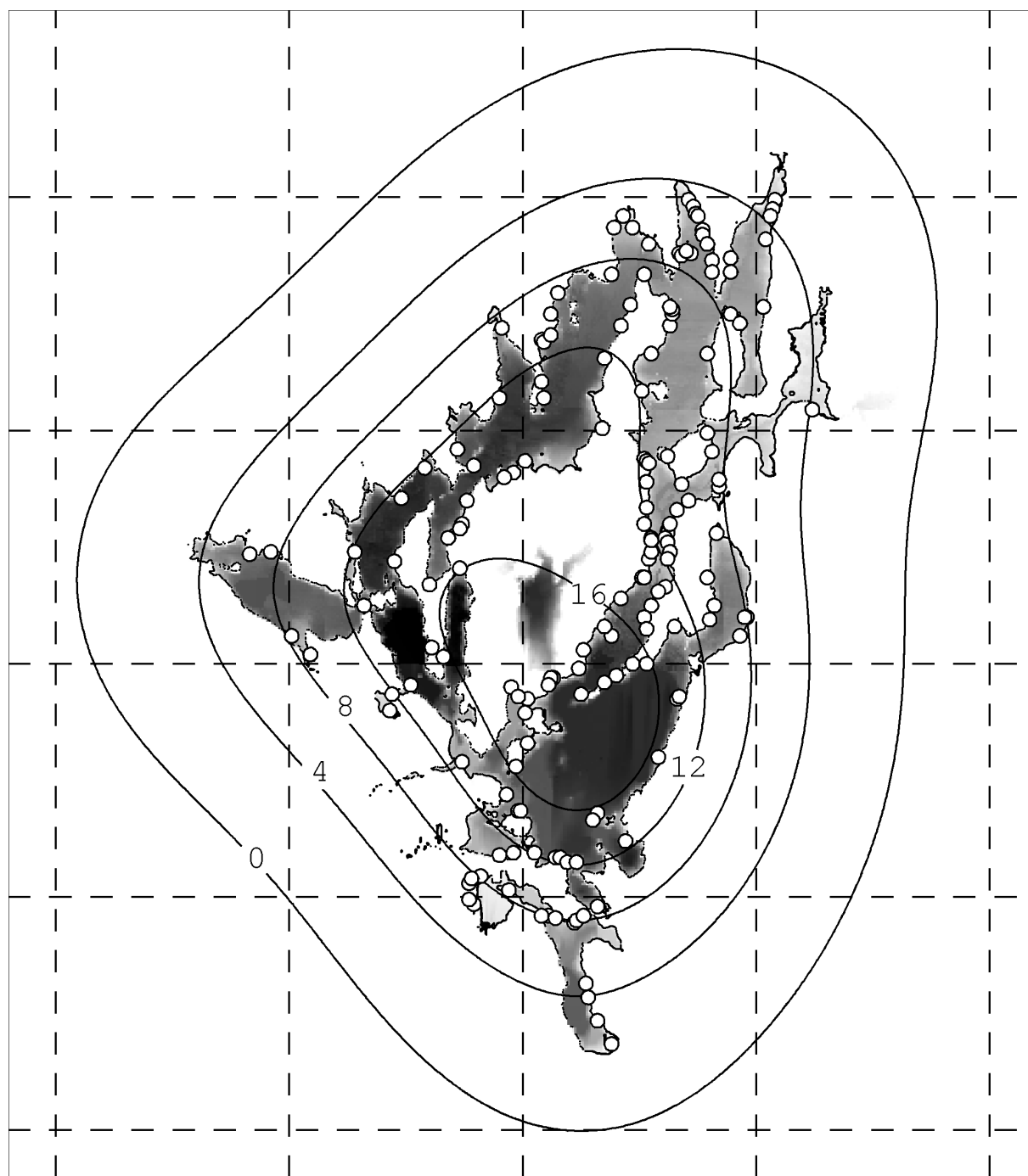


Bonneville deflection histories

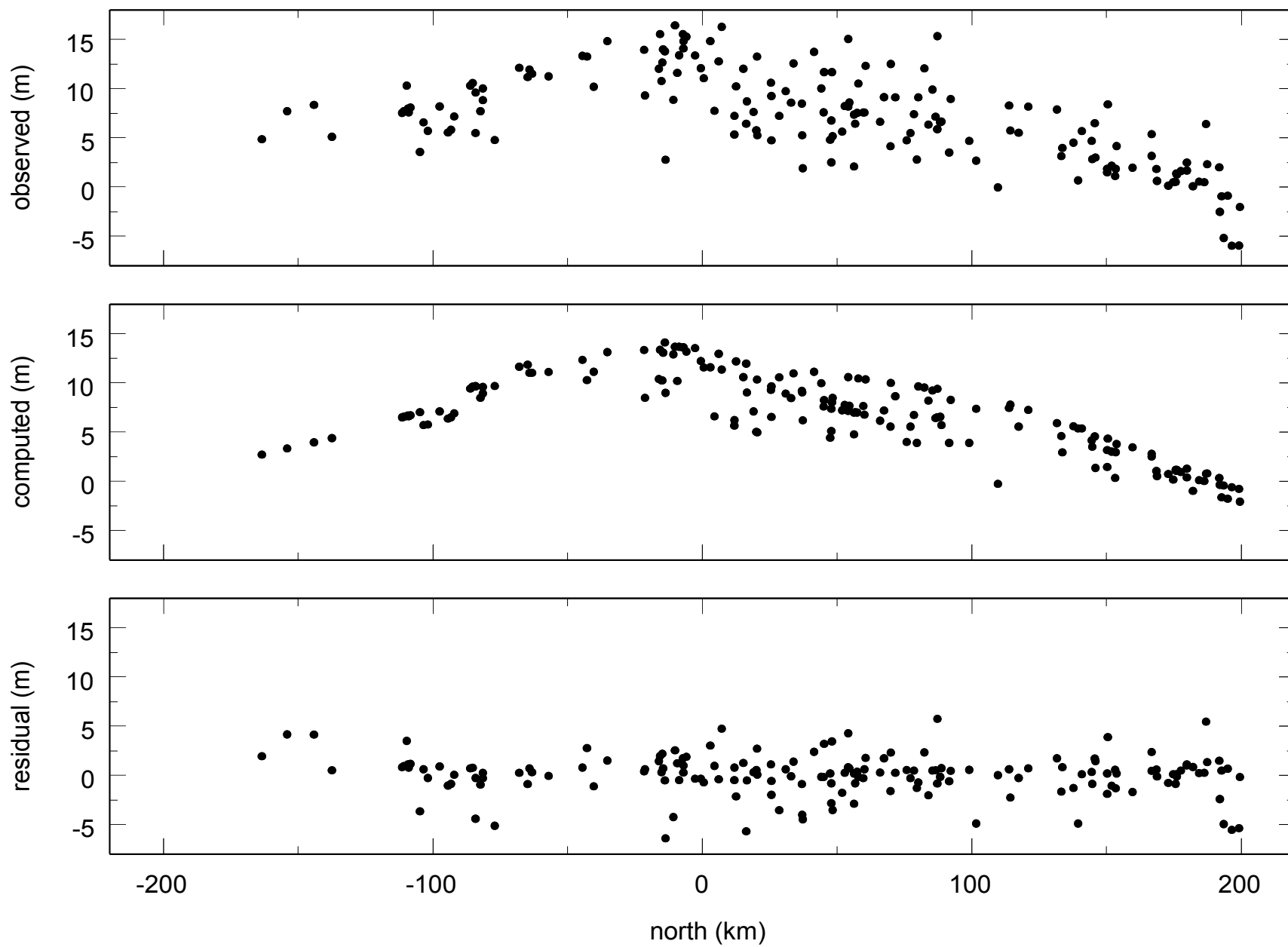


lake Lahontan

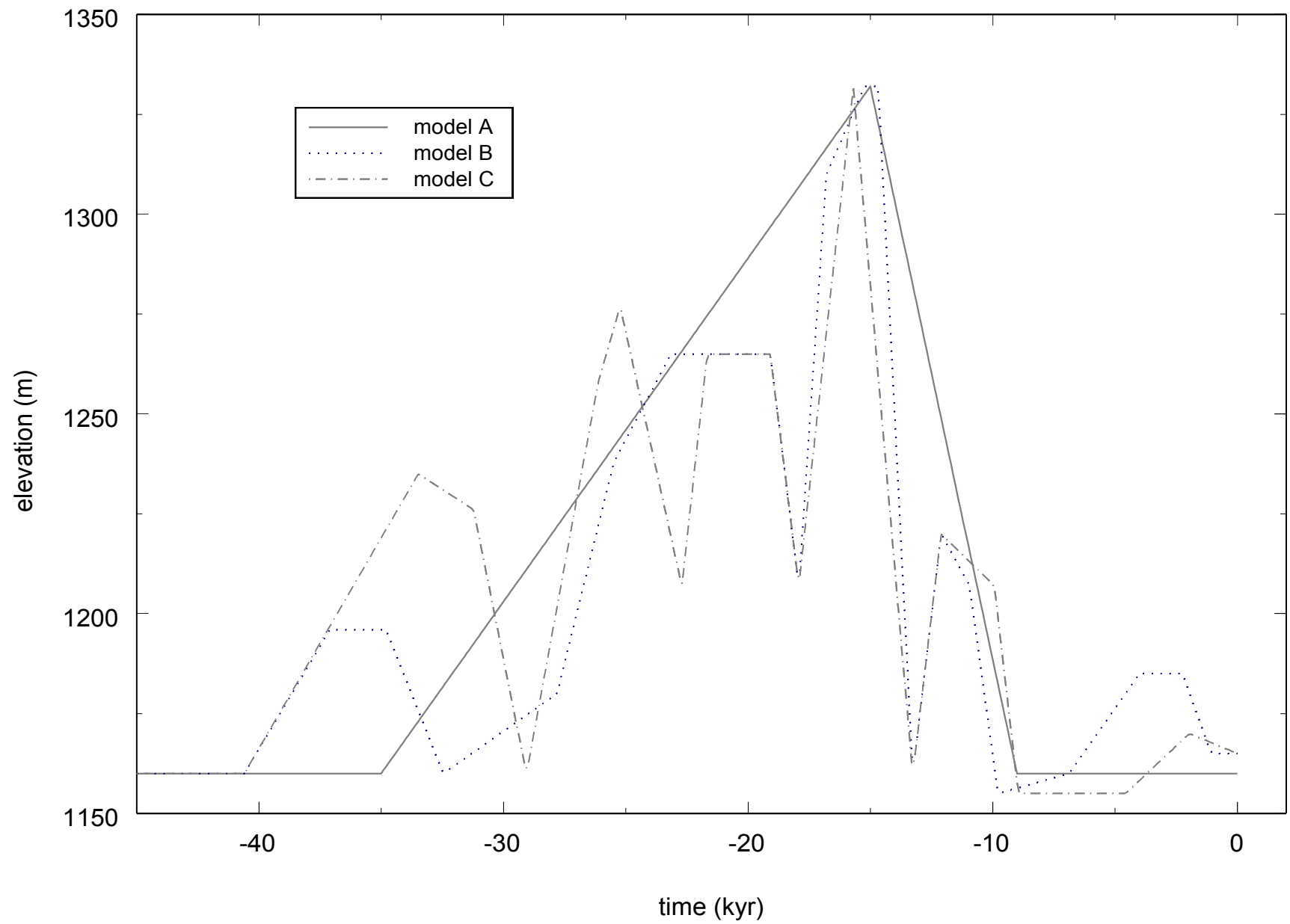




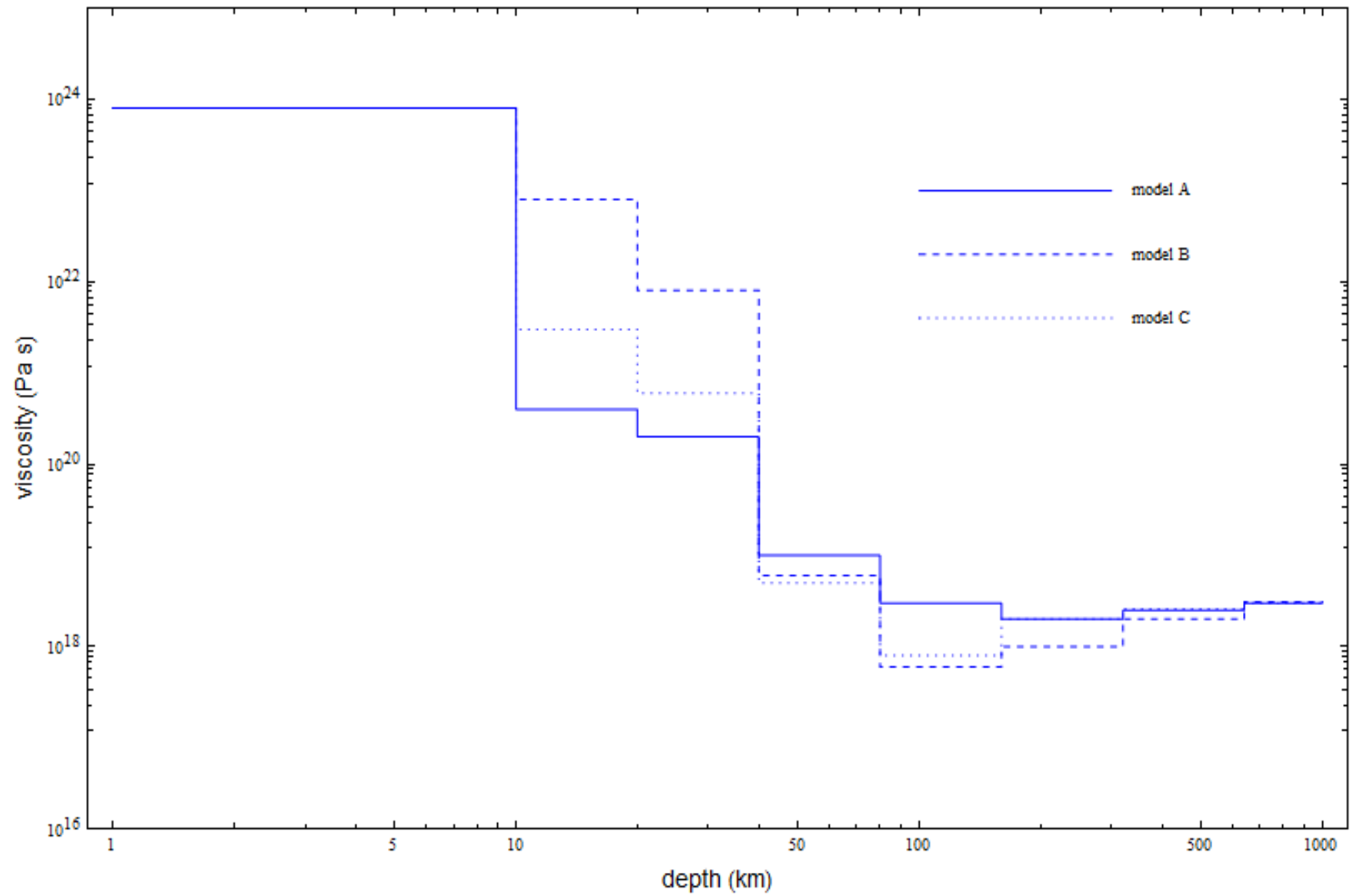
shoreline elevation pattern projected onto north-south line



Lake Elevation Histories



Lahontan basin viscosity model



compare Bonneville and Lahontan viscosity models

