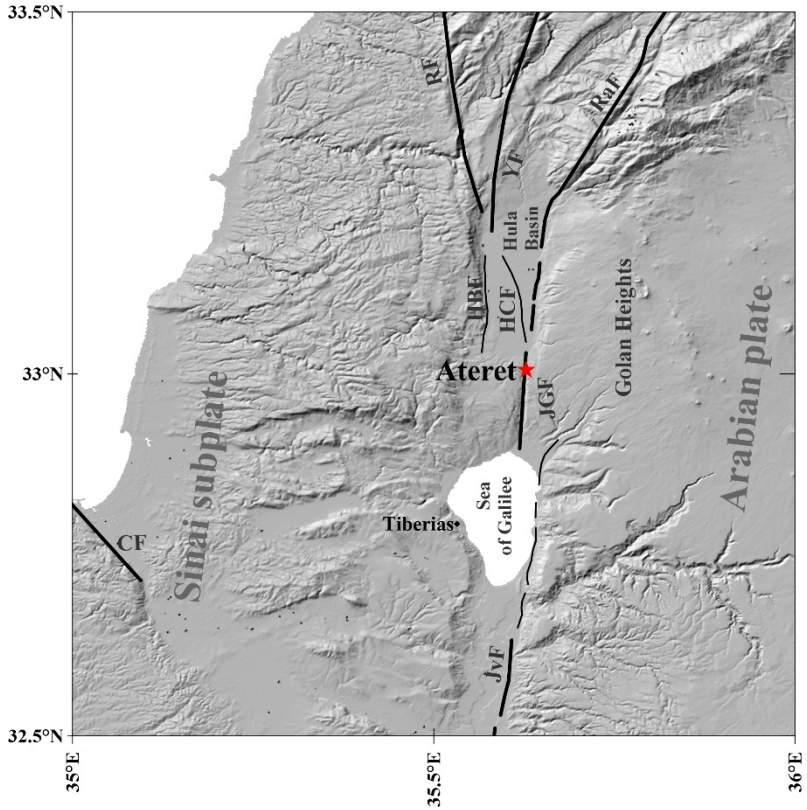
ITASCA™

Archaeoseismological investigation of the deformation of the ruin of the crusader fortress Ateret, Israel with 3DEC

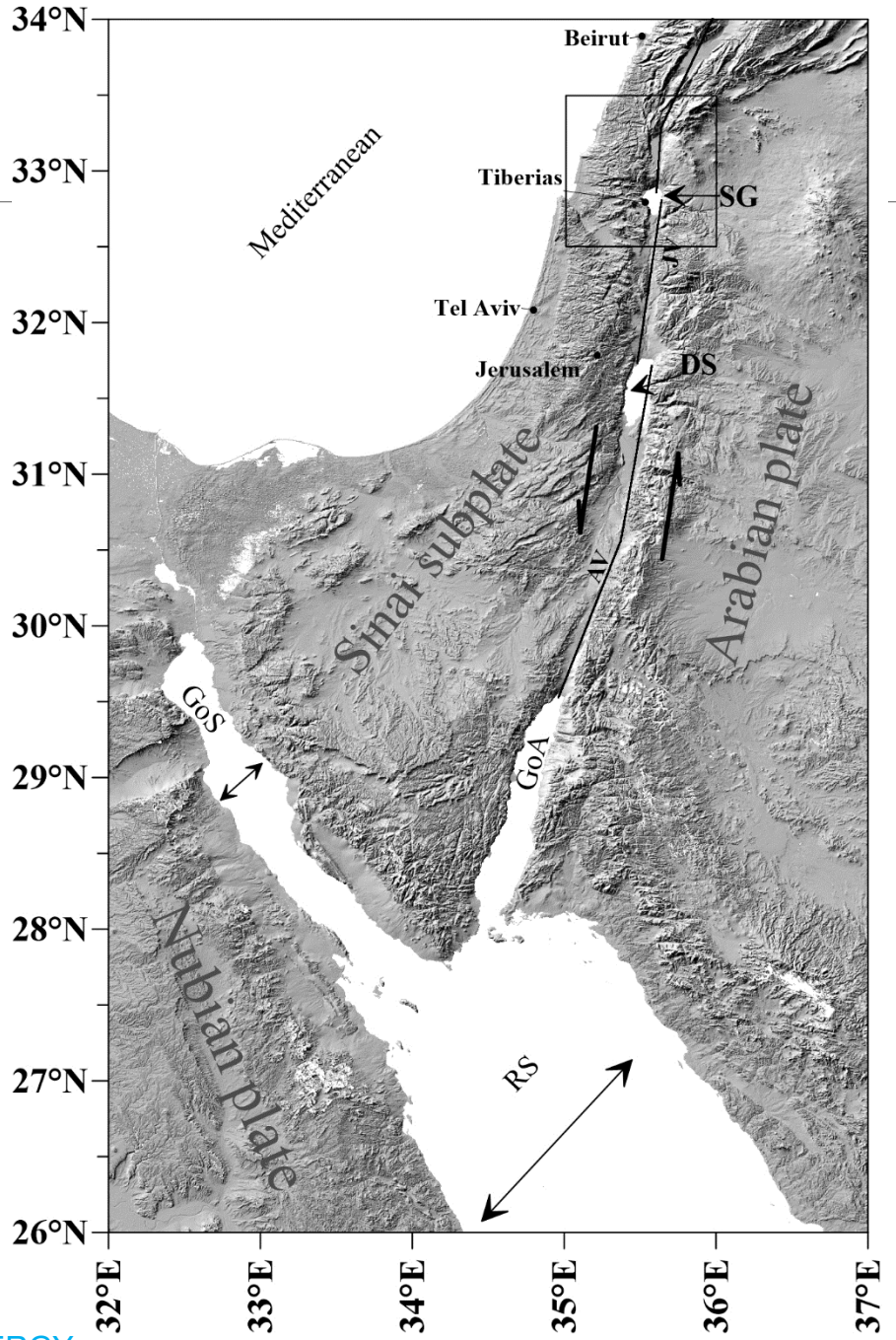
Archaeoseismology

- Damages from pre-instrumental earthquakes in archaeological sites
- Extending the database for earthquake catalogues
- New insights into contemporary history

Working area Israel

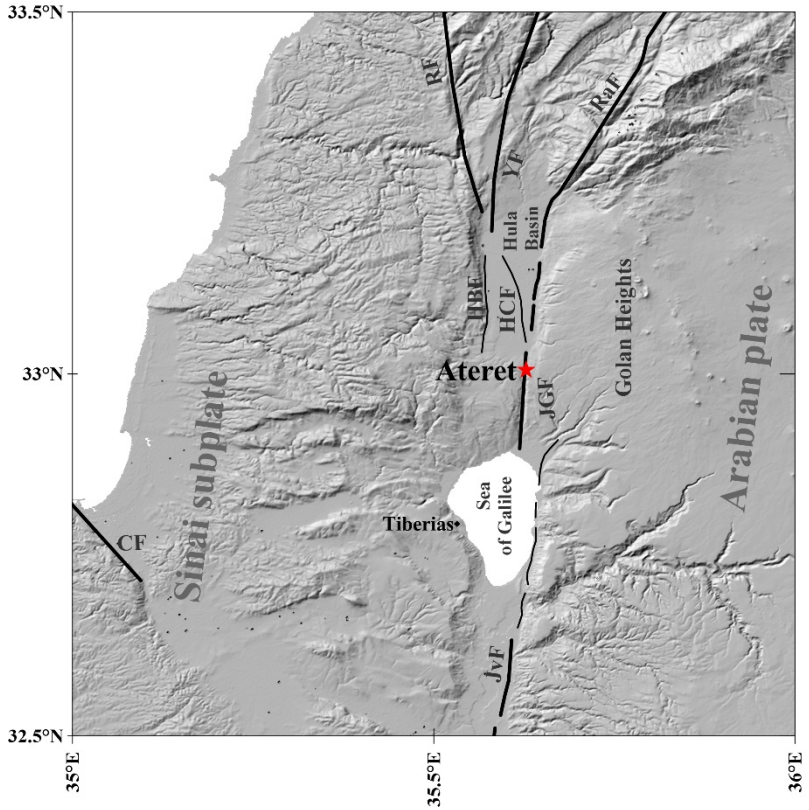


(after Schweppe *et al.* 2017)

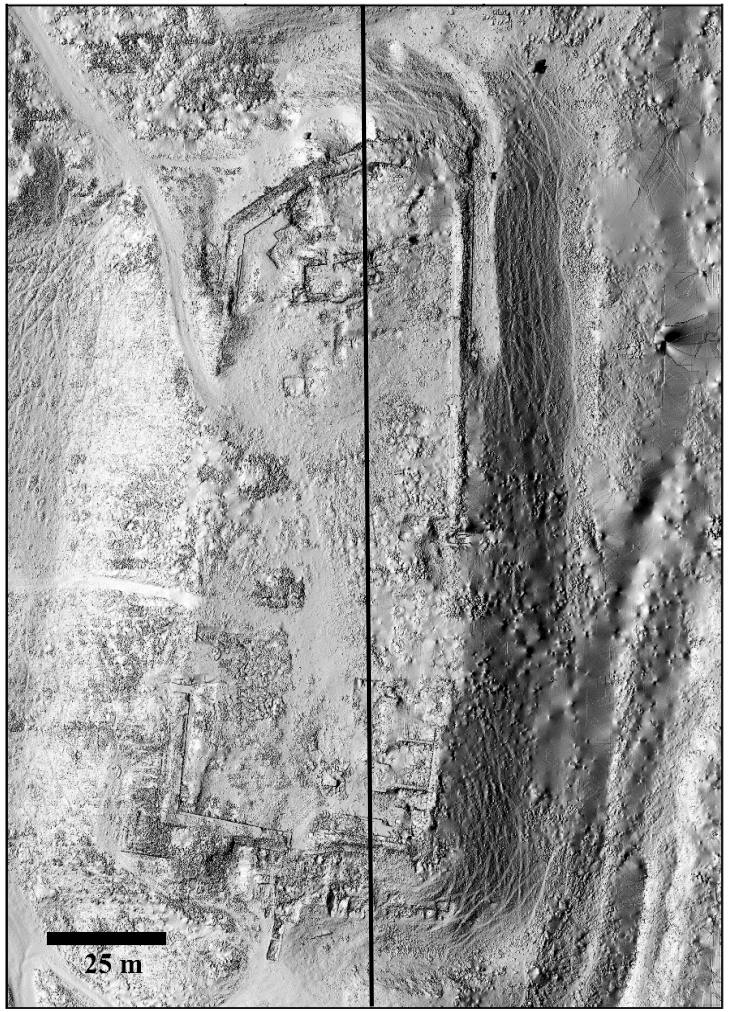


ITASCA™

Working area Israel



(after Schweppe *et al.* 2017)

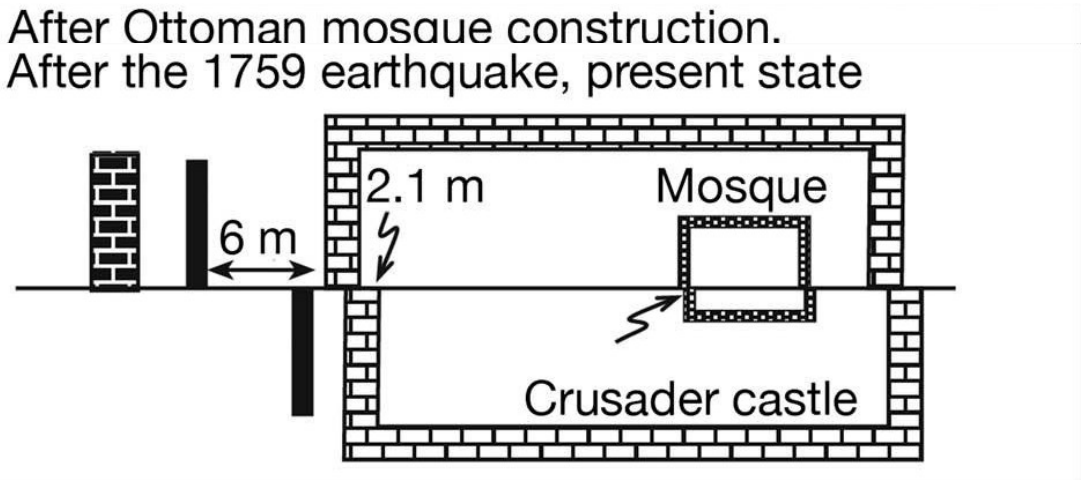


(after Hinzen *et al.* 2017)

(Photo left: Hinzen)

Earthquake history of the site

- Abandoned in 1179
- 25. May 1202
  - M_S 7.4[1]
  - Offset 1.25 m
- 30. October 1759
  - M_S 6.6[1]
  - Offset 0.5 m



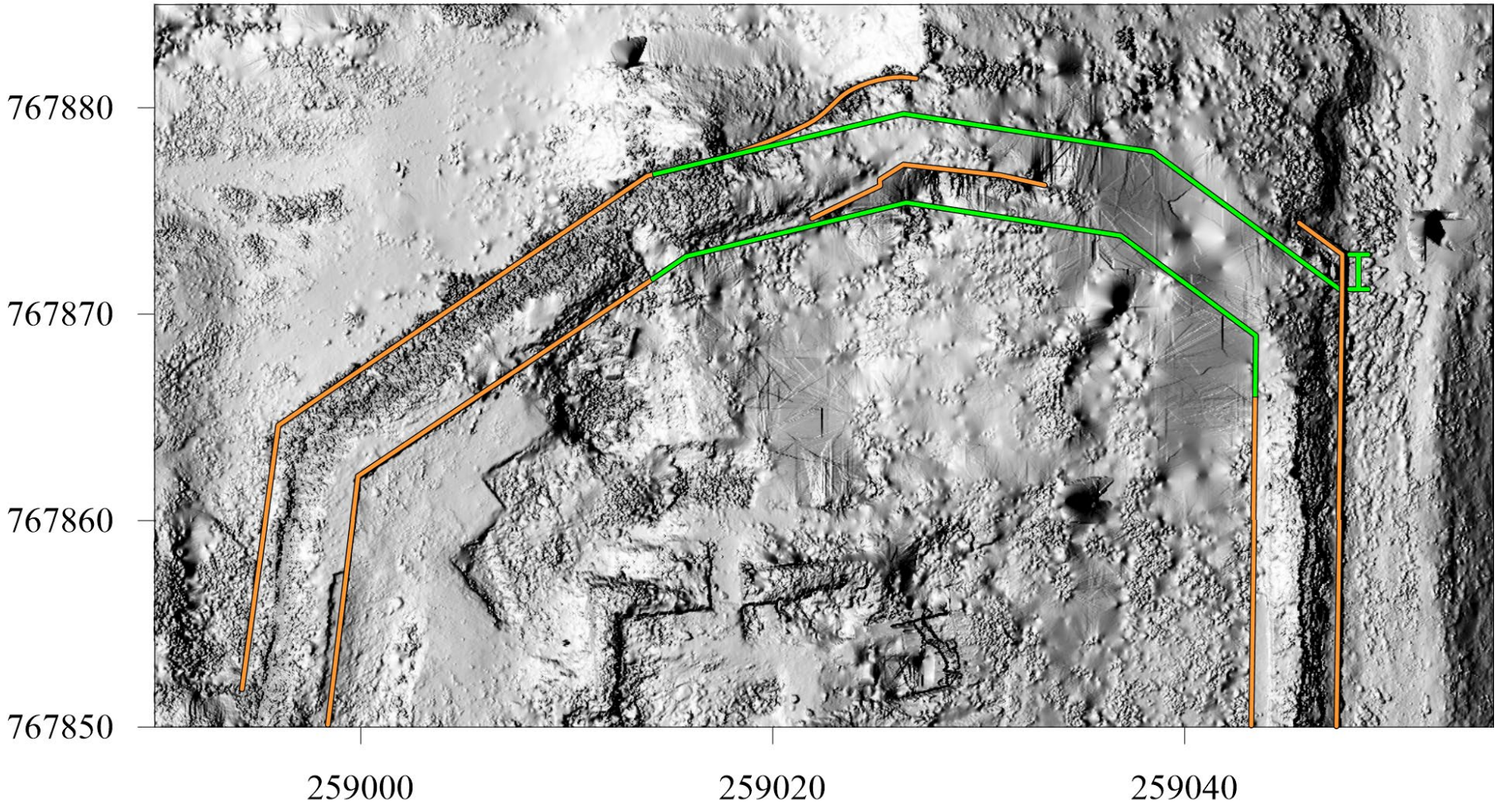
(after Ellenblum *et al.* 2015)

([1] Ambrasyes and Melville 1988)

Questions addressed to the site

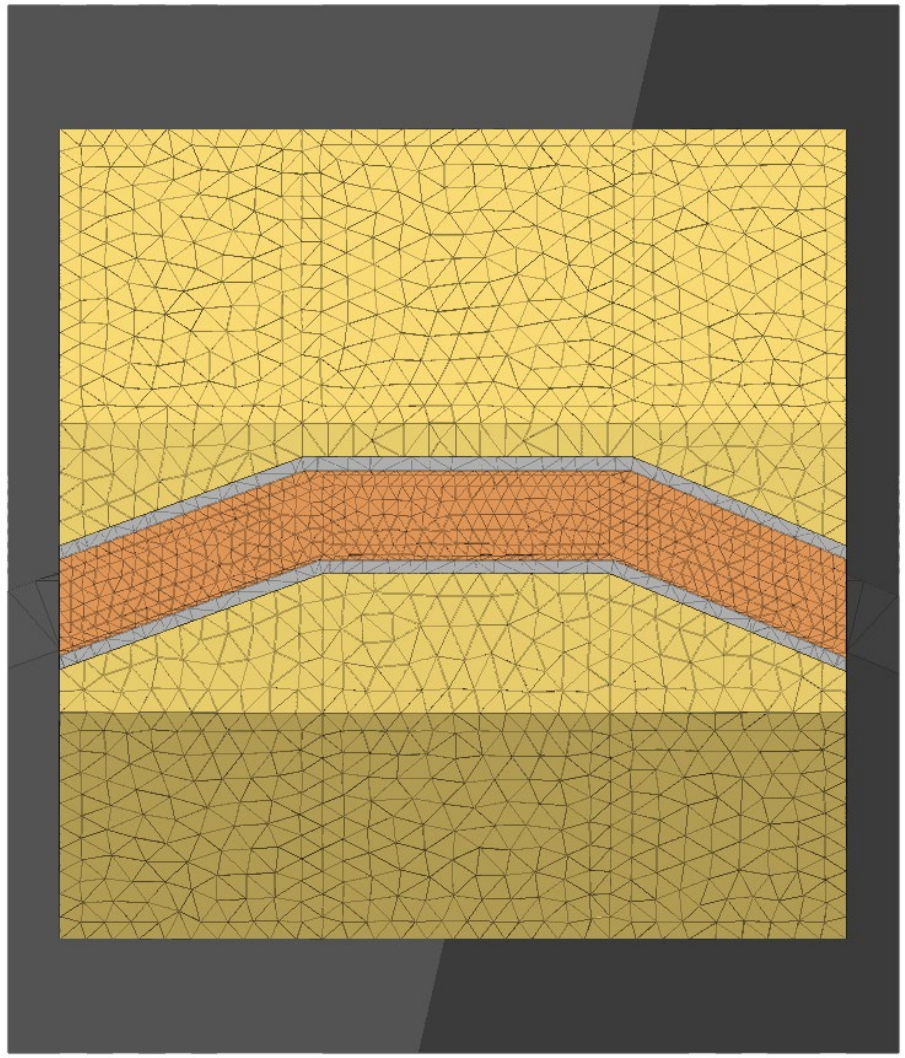
- Does the dislocation velocity affect the deformation pattern of the fortification walls?
- Is it possible to decide, based on the deformation pattern of the wall, whether the total offset is the result of a rapid coseismic movement or does slow creep movement have to be considered as well?
- Can new insights be gained on the dislocation velocity of the individual events?
- Is it possible to discern the amount of slip by which the two sides of the fault contributed to the total displacement? And in the case of a coseismic displacement, a follow up question is: Is it possible to distinguish between the effects of the two earthquakes?

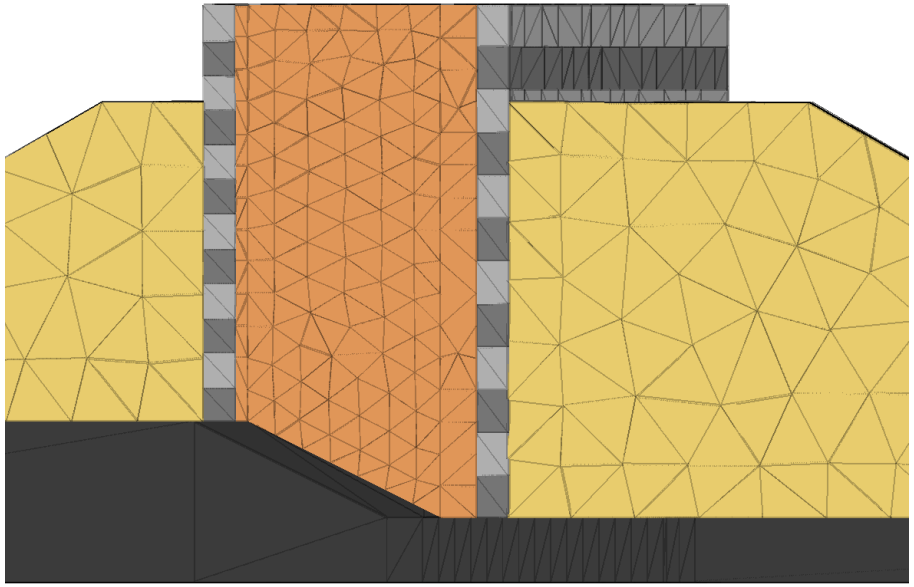
Reconstruction



(after Hinzen *et al.* 2017)

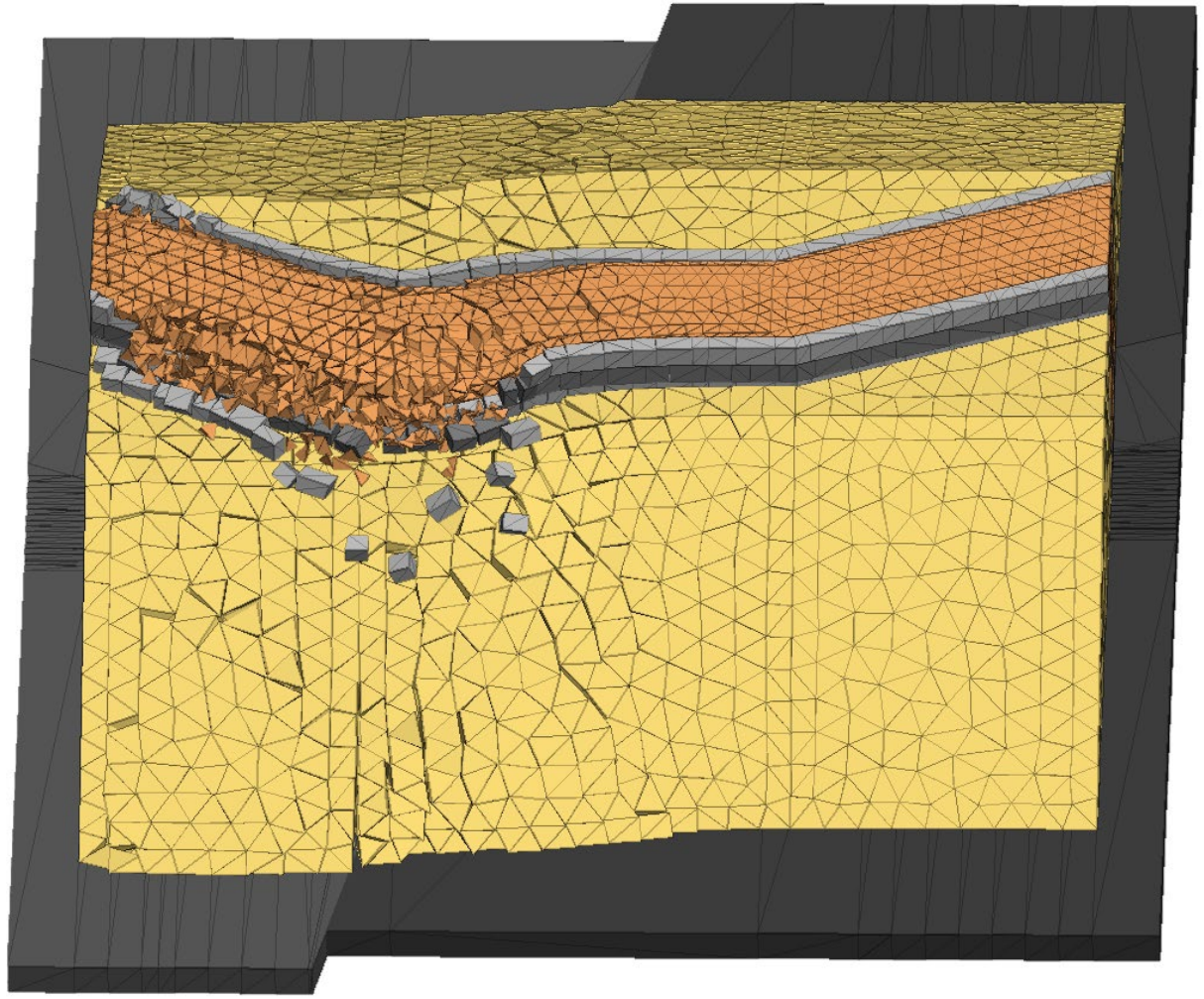
Model Creation





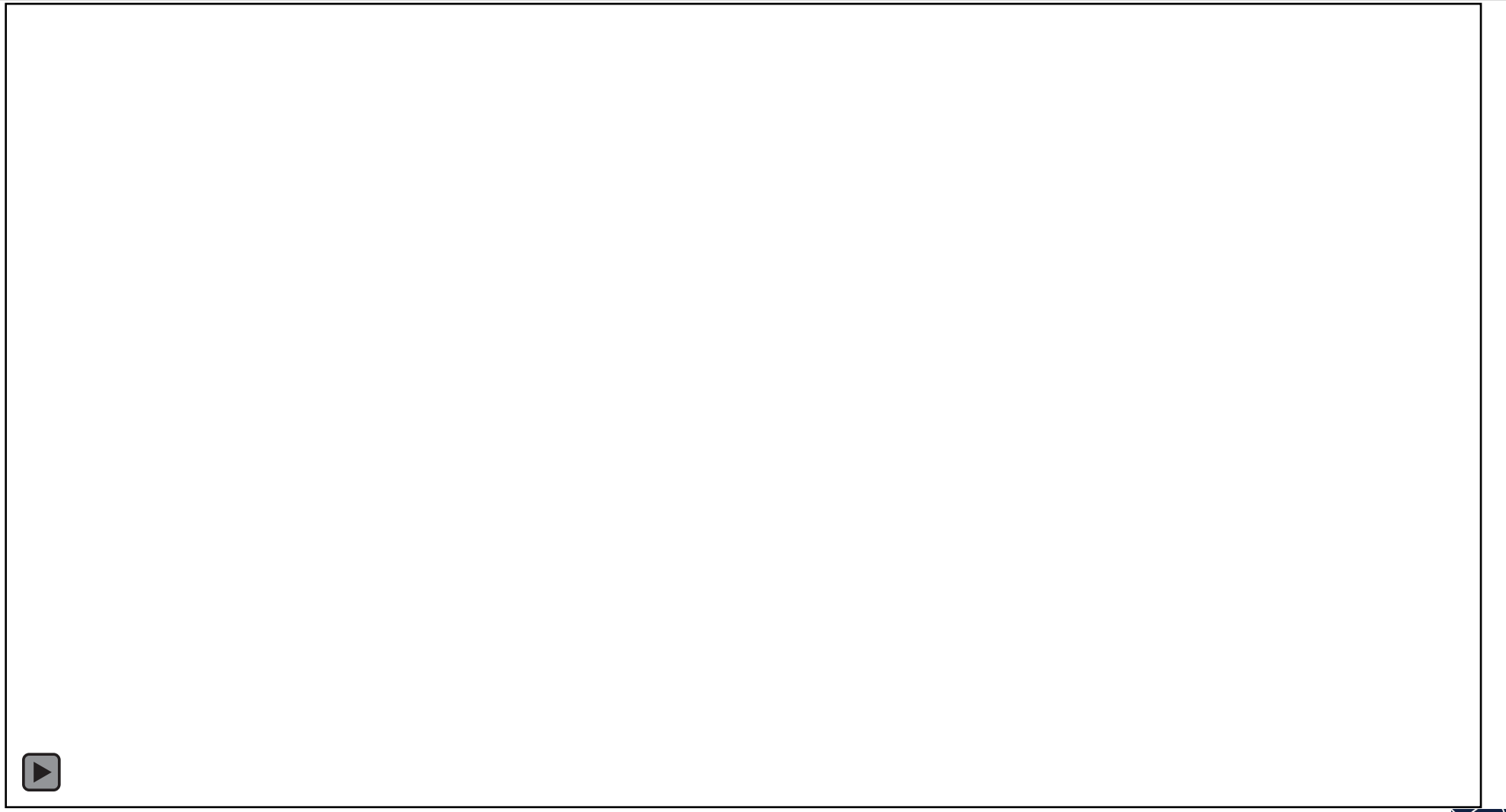
Simulations

- In total 58 Simulations
- Separated into two scenarios

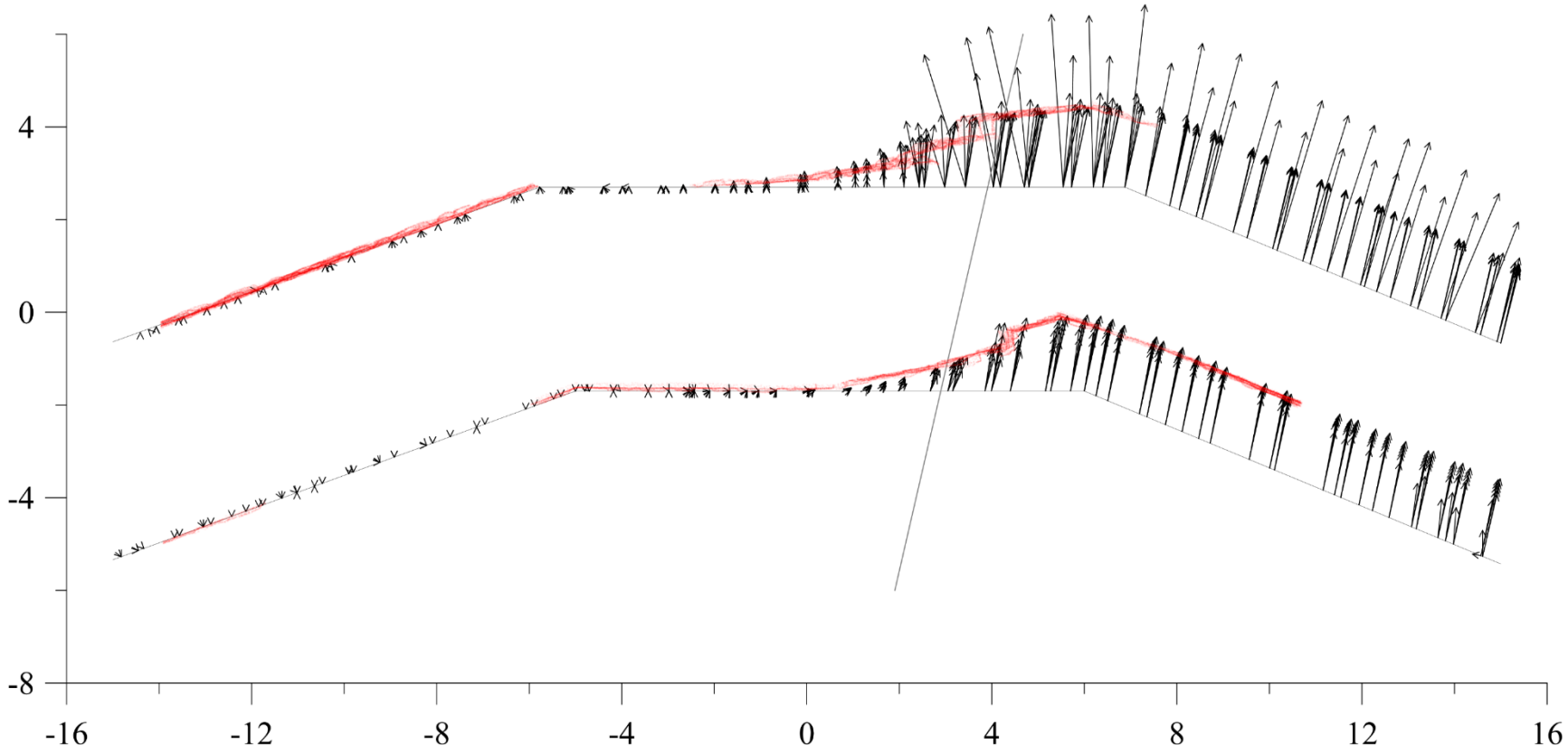


First Scenario

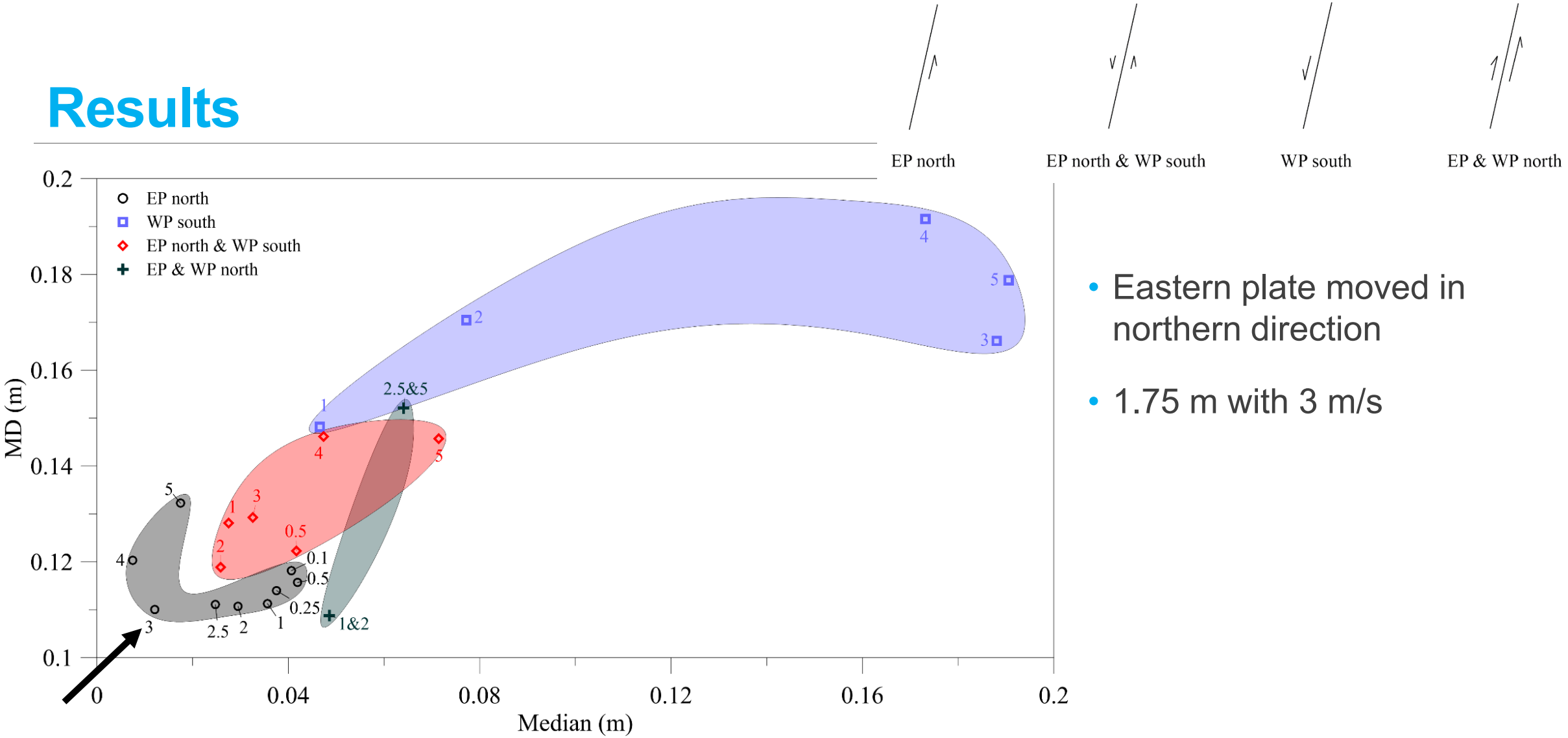
- Only one movement
- Four different movement directions with slip velocities ranging from 0.1 – 5.0 m/s



Results



Results



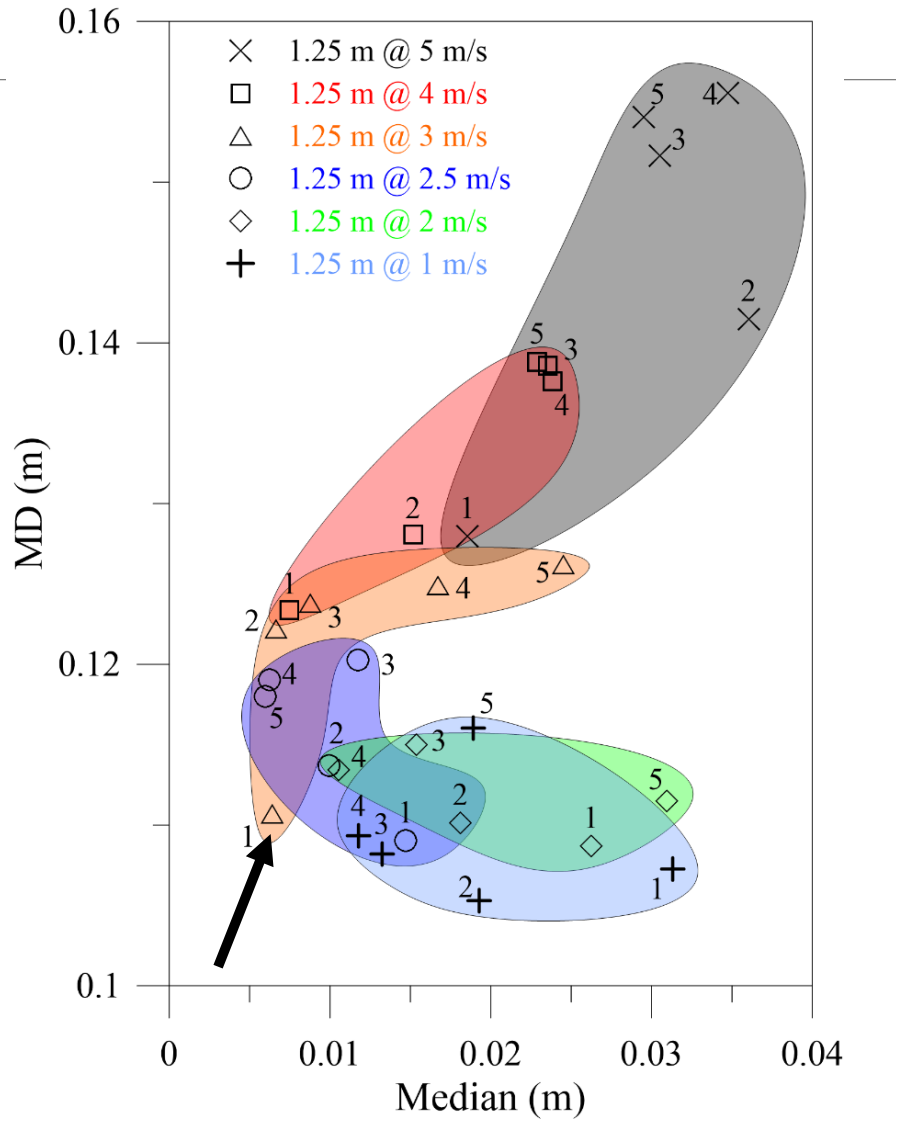
- Eastern plate moved in northern direction
- 1.75 m with 3 m/s

Second scenario

- Simulation of the two earthquake
  - First offset 1.25 m
  - Second offset 0.5 m
  - Slip velocities between 1.0 and 5.0 m/s

Results

- Offset: 1.25 m Velocity: 3.0 m/s
  - Intensity IX[1] (Lit: VIII-IX[2])
  - M_S 7.4[2] (Lit: M_S 7.6[2])
- Offset: 0.5 m Velocity: 1.0 m/s
  - Intensity VII[1] (Lit: IV-VIII[3])
  - M_S 6.7[2] (Lit: M_S 6.6[4])



([1] Wald *et al.* 1999) ([4] Ambrasyes and Barazangi 1989)
([2] Ambrasyes and Melville 1988)
([3] Sbeinati *et al.* 2005)

Conclusion

- DEM good possibly to quantify parameters of past earthquake
- In certain situations (as in Ateret) information about tectonic movement is possible
  - Good documentation of the archaeological site
  - Option for the reconstruction (archaeological, historical information)
  - Knowledge of the used building materials

Thank you very much!