Shear-tensile source model: West Bohemia/Vogtland swarm in 1997

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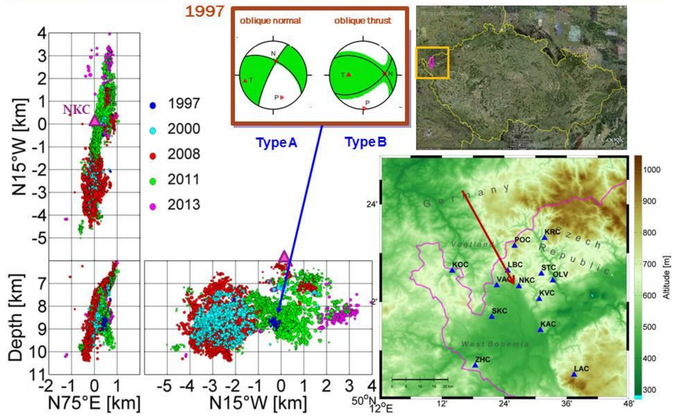
West Bohemia/Vogtland – earthquake swarm 1997



Events of two types in the swarm: A (shear), B (non-shear)

Is the departure from the shear-slip at the B events real ?

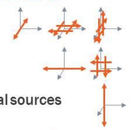
Answer by detailed assessing of quality of the mechanism retrieval: comparison of two source models, confidence regions

Theory

Source models

Moment tensor (MT)

- general dipole source

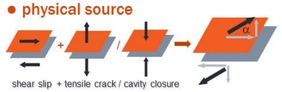


BUT too general → includes unphysical sources

- 6 inversion parameters :
  - M_{11}, M_{22}, M_{33}, M_{12}, M_{13} and M_{23}
- advantage :
  - linear inverse problem
- disadvantage :
  - spurious non-DC components

Shear-tensile crack (STC)

- physical source



Dufumier & Rivera 1997, Vavryčuk 2001, 2011

- 5 inversion parameters :
  - 4 angles (ϕ, δ, λ, α), magnitude
- advantage :
  - pure physical source
  - less parameters, i.e. more robust
- disadvantage :
  - non-linear inverse problem

Confidence zones: definition

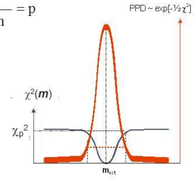
- part of model space comprising points yielding a good match to data

$\chi^2(\boldsymbol{m})$ … likelihood fcn: RMS/dispersion $\quad \chi^2(\boldsymbol{m}) < \chi^2_p$

- construction assuming a priori chosen probability level *p*: e.g., 90%, 95%,99%

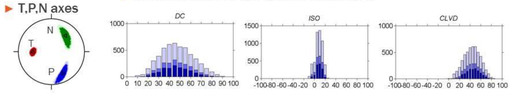
χ_p^2 … chosen to satisfy: $\dfrac{\int_{\chi^2(\mathbf{m})<\chi_p^2} \mathrm{PPD}\,\mathrm{dm}}{\int_{\mathbf{m}} \mathrm{PPD}\,\mathrm{dm}} = p$

- indication of quality of the solution
  - large conf.zones → poor solution
  - small conf.zones → good solution

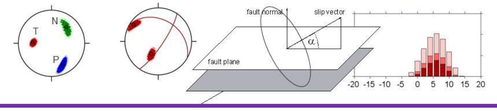


Confidence zones: display

- confidence zones of MT
  - T,P,N axes
  - decomposition: DC,ISO,CLVD percentage

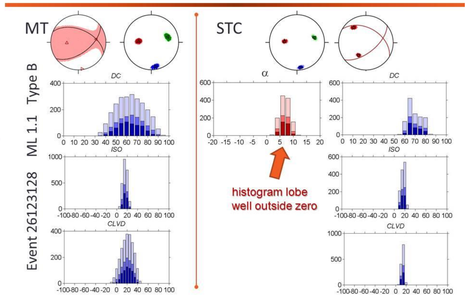


- confidence zones of STC
  - T,P,N axes *or* poles of source planes
  - slope angle

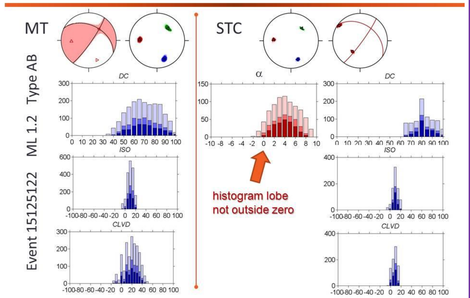


MT vs. STC event examples

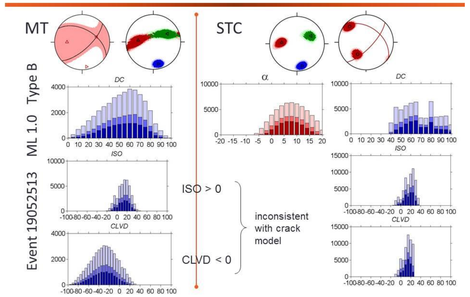
Well constrained solution: reliable non-DC component



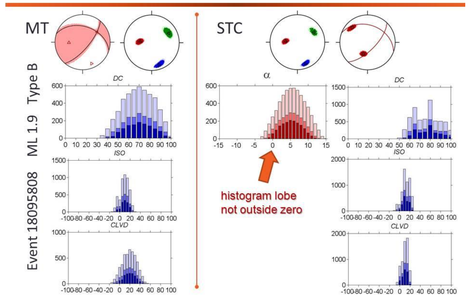
Well constrained solution but unreliable non-DC component



Less constrained solution: unreliable non-DC component

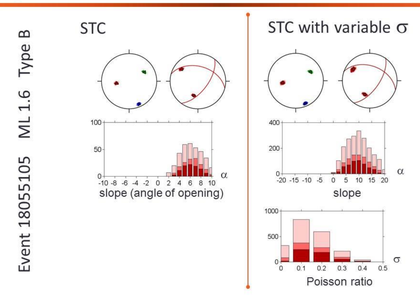


Well constrained solution but unreliable non-DC component

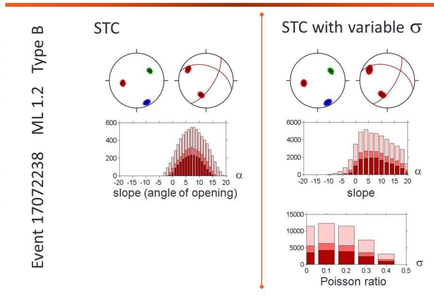


STC Poisson ratio optimization

Optimization of Poisson ratio

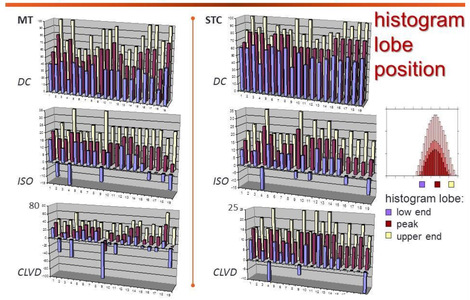


Optimization of Poisson ratio

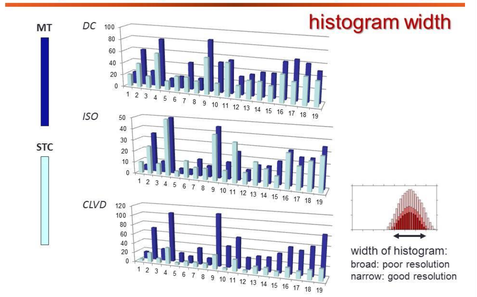


MT vs. STC summary

Composite graphs: DC,ISO,CLVD percentage



Composite graphs: DC,ISO,CLVD percentage



Conclusions

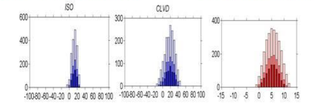
Type B earthquakes: notable non-DC component

19 events investigated

Assuming quality of the solution from P and S amplitude inversion, is it significant ?

i.e., is the error of non-DC small enough?

In terms of two models: MT (ISO,CLVD) STC (slope angle)

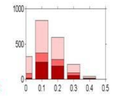


answer = YES MT: 15 events, STC: 15 events out of 19

Quality of STC vs. MT solution?

STC distributions narrower → constrained better

Chance to optimize Poisson ratio? **Low** (wide histogram)



A better prospect possibly for more data: stations, coverage