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Impact of channel-like erosion patterns on the frequency-magnitude distribution of earthquakes

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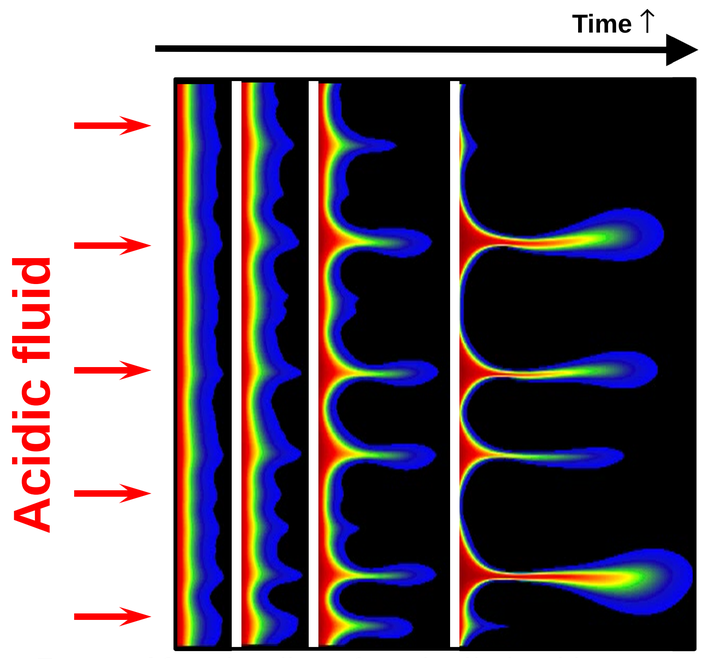
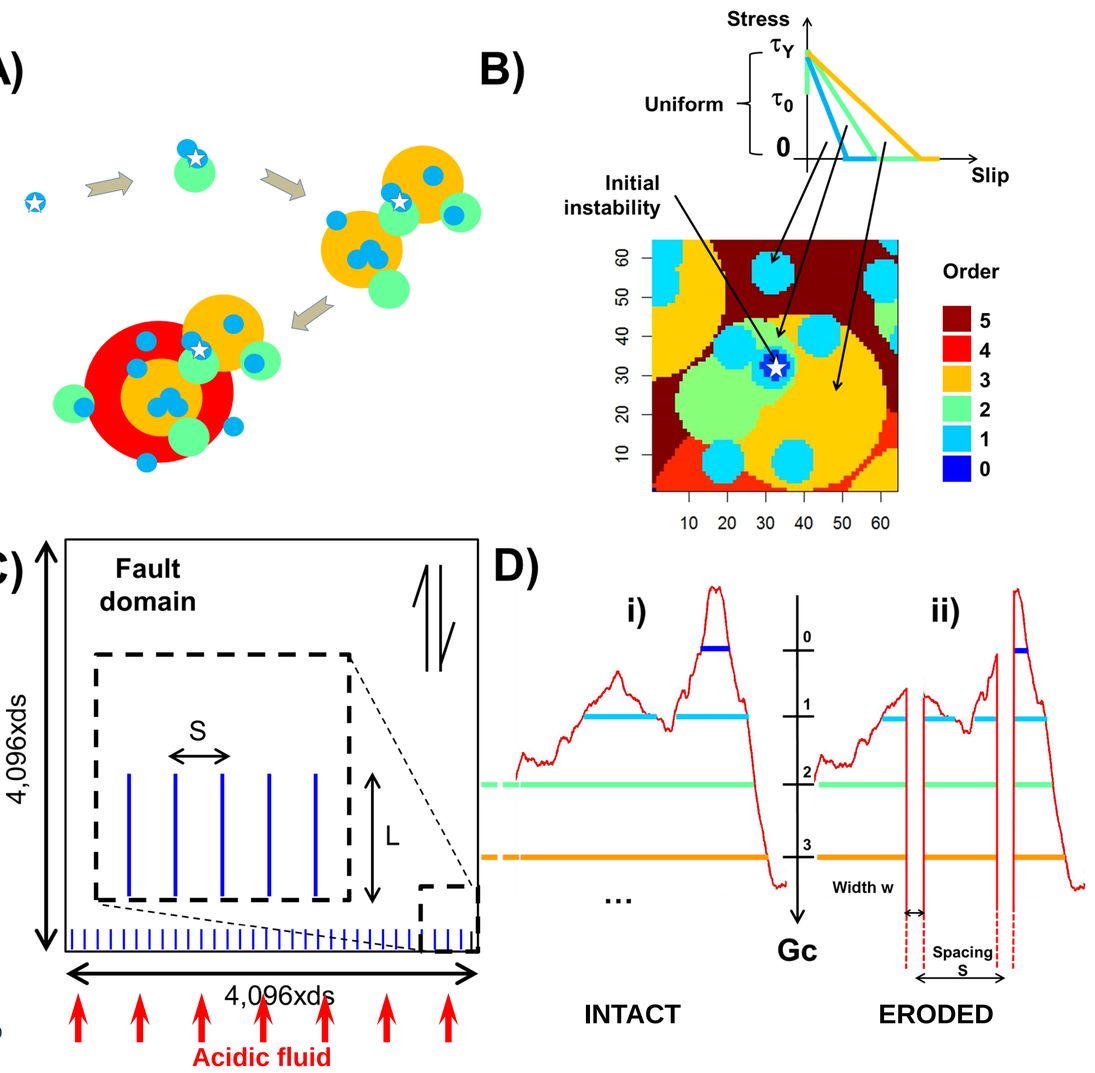
Wormholes induced by dissolution



Extracted from http://www.fuw.edu.pl/~piotrek/c.mpg

Depending on the flow and reaction rates, instability of the dissolution front can lead to a **wormhole-like pronounced erosion pattern** [Szymczak & Ladd 09].

Earthquake as a cascading rupture growth process



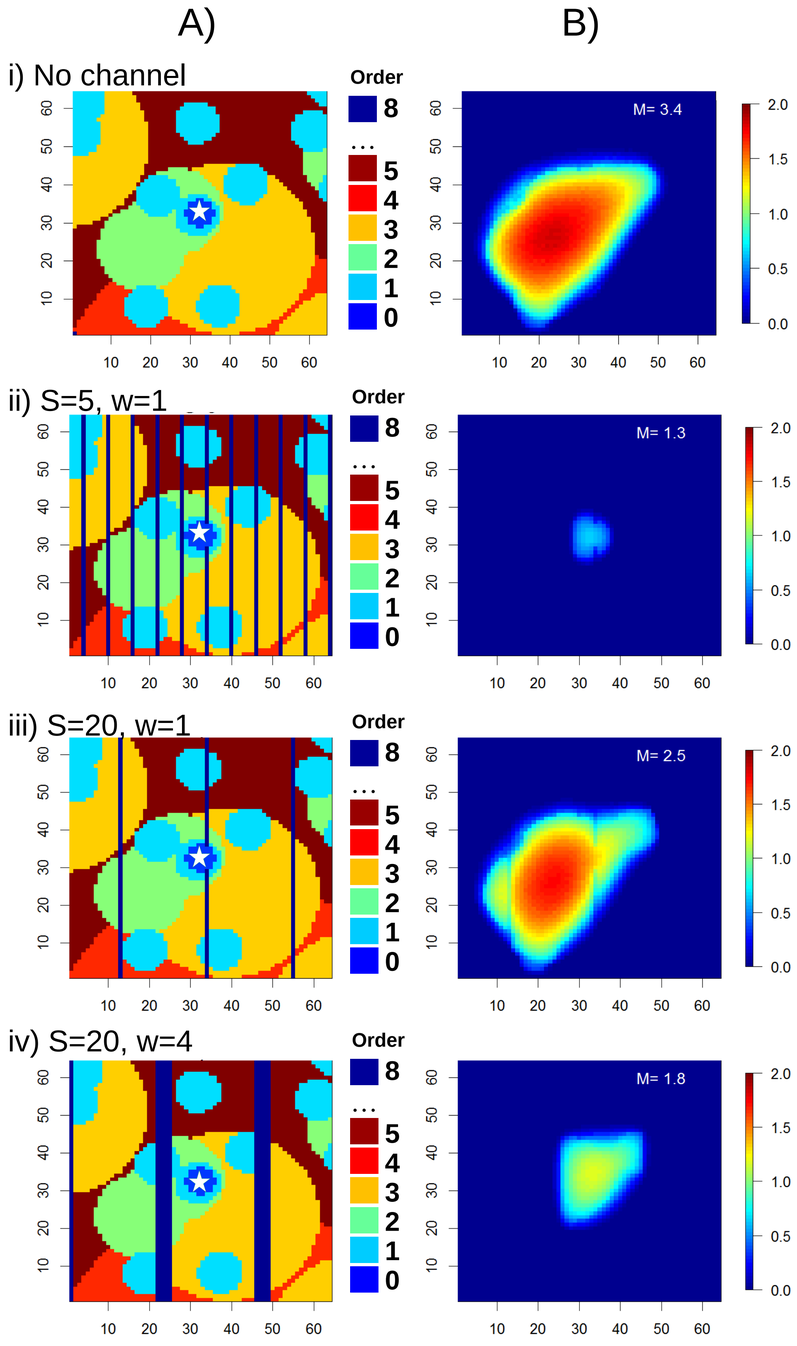
A) Fractal circular patch model [Ide & Aochi 05]. A small rupture is initiated (star-like marker) and propagates on one of the smallest patches (lowest fracture energy area) and grows up on larger patches with a progression depending on the interaction between patches;

B) Example of patches' distribution. Circular patches of different sizes (order in right bar) are distributed on a planar fault. Each patch has slip weakening friction law (inset), with slip weakening distance Dc proportional to the patch radius;

C) Fault domain (4,096×4,096) with position of the aligned channels (characterised by a length L and a spacing S) with same direction as the shear stress acting on the fault (ds is the grid cell size assumed to be 4m in the present study);

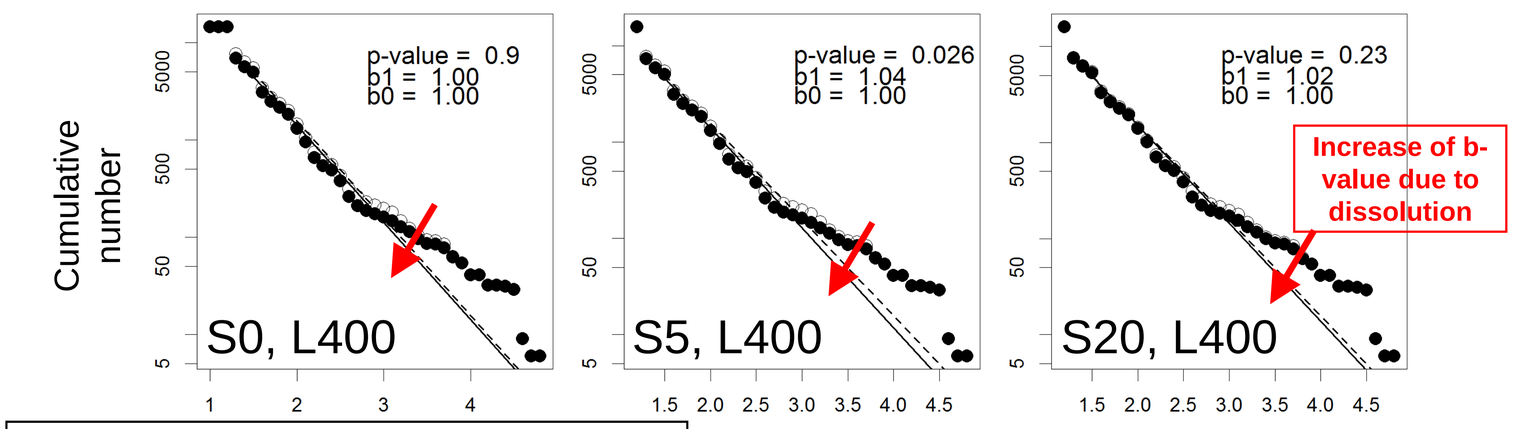
D) Schematic representation of: i) the fracture microtopography viewed as a series of patches of increasing energy Gc depending on the order of the patch; ii) the deep erosion induced by channels through the whole series of patches until reaching the host rock (8th largest patch).

Channel pattern's effect on rupture



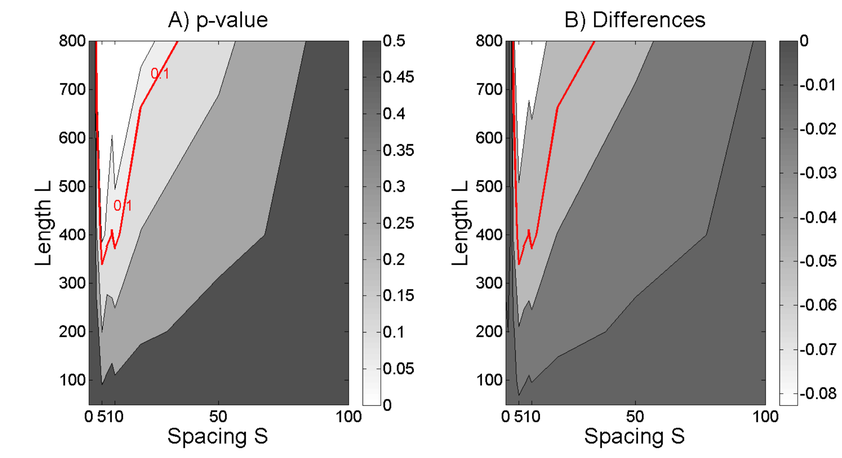
Spatial distribution of patches (A) and corresponding **slip spatial distribution** in mm (B) given a rupture sequence initiated at the central zero-order patch (dark blue). The channels are outlined by dark blue vertical lines (order 8) considering: i) Original patch distribution; ii) Channel-like pattern with different spacings and widths. The final magnitude value of the generated earthquake is indicated in white.

Impact on Frequency-Magnitude Distribution



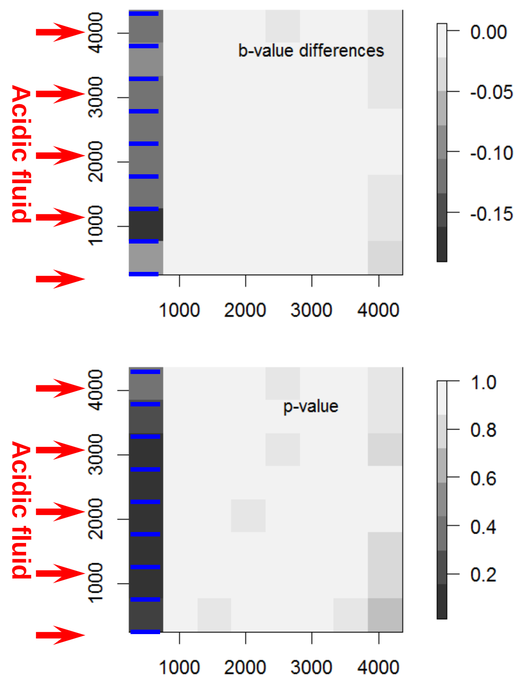
b1 = b-value for eroded fault
b0 = b-value for intact fault
p-value = statistical significance of the differences if <10%

Influence of channels' characteristics



Parameter space study considering different spacing versus length scenarios (channel width *w*=1): (A) statistical significance *p*-value (using 1,000 random samples) of the Differences in the b-values (orginal minus altered cases); Cases with *p*-value <10% (area indicated by the red-coloured lines) are categorised as "statistically significant" (B).

Spatial Analysis S10, L400



CONCLUDING REMARKS [Rohmer & Aochi 15]

- A spatially **uniform dissolution** ➔ b-value remains unchanged;
- Channel-like erosion ➔ **increase of b-value** (of ~0.08 in our case);
- Impact is significant (statistically) for **optimum characteristics** of the erosion pattern with spacing to length ratio of ~1/40;
- The larger the spacing, the lower the channel's influence;
- **Local seismicity anomaly** concentrates in a limited zone around the channels: this opens perspective for detecting these eroded regions through high-resolution imaging surveys.

References

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Acknowledgments

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