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Project title: Impact of fault envelope architecture on reservoir fluid flow

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Object
The main object of the project is to study fluid flow behaviour in fault zones using reservoir models that capture explicit fault envelope architecture and properties (fault facies models). The study will investigate the potential of these models by focussing on key issues related to the employment of explicit fault architectures in reservoir models including upscaling of these models for simulation purposes and how to employ the methods in scenarios involving intersecting faults. Results will be utilized to establish improved routines for fault facies modelling and perform a comparative benchmark study of a fault facies type model and a model using conventional fault modelling tools. The benchmark will involve a sector model of a realistic case.

Status:
The project is progressing according to plan. Work has focussed on providing modelling techniques for fault zones, methods for describing and capturing individual elements of the fault zone architecture and new methods for evaluating uncertainty of flow properties. Results can be summarized as follows::

1. Statistical model of faces distribution in the fault zone.
A statistical model of fault faces distribution in fault cores using truncated gaussian distribution is being developed. This model is combined with layered model developed in [1] and yields a qualitative representation of a fault zone. The model has a high degree of flexibility allowing description of a large range of geological scenarios.

2. Variability of thickness along deformation bands and its influence on flow properties.
The statistical analysis of thickness t(x) along the deformation bands collected by Haakon Fossen and Atle Rotevatn (CIPR) is performed. t(x) is considered as stationary random process. A semivariance is evaluated using a moving window estimator [2]. Two matlab scripts are being developed for simulation of bands' geometry and thickness along each band. The work is performing in cooperation with Mathematical Department of Bergen University. Now we are waiting for results of first numerical computations and new data of field measurements.

3. Scaling of relationships of faults' attributes.
This work is devoted to statistical analysis of faults' properties (length L, maximal displacement D, width of deformation zone W, thickness of fault core T) collected by Anita Torabi (CIPR) from 72 different references. The usual assumption of power law relationship between faults' properties is used. The Bayesian Information Criterion is used to define the optimal number of parameters of statistical model [3]. Preliminary numerical calculations show the existing of two statistically significant slopes in log-log relation D-L.

4. Uncertainty analysis of flow properties.
Because of random distribution of fault faces the flow properties of flow in fault zone are also random functions. The uncertainty analysis by direct Monte Carlo simulation can be very time consuming. The probabilistic collocation method [4] is used as alternative approach. The polynomial chaos expansion is used for representation of random functions. The purpose of this work is to apply the described approach to statistical fault's model developed in 1. First results show that this approach can be applied to models with discontinuous permeability. However the precision of these computations much worse than in the case of usually used smooth lognormal permeability distribution.

5. Fracturing process.
This work is performed in cooperation with Irene Mannino from University of Rom. She has collected the geometrical ratio H/S related to fractures from 26 normal faults. First correlation analysis with faults' attributes was performed. New simplified approximation of corresponding experimental curves was suggested.

References:
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[3] Main, I.G., T. Leonard, O. Papasouliotis, C.G. Hatton & P.G. Meredith. One slope or two? Detecting statistically-significant breaks of slope in geophysical data, with application to fracture scaling relationships, Geophys. Res. Lett. 26, 2801-2804, 1999.
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Publications: