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Interactive comment on "Stress field sensitivity analysis in a sedimentary sequence of the Alpine foreland, Northern Switzerland" *by* T. Hergert et al.

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1) We add the following information on page 6 line 25: "The faults are represented as frictional contact surfaces that are not allowed to penetrate or separate from each and on which slip is possible according to Coulomb's friction law."

2) The modelled SH orientation at the location of the Weiach well agrees very well with the B-quality data record from the Weiach well with SH orientation of 172° between 560-2276 m drilled depth derived from 772 m borehole breakout length (Heidbach & Reinecker, 2013). A second C-quality data record from the Weiach well shows SH orientation of 134° representing the depth section 408 558 m drilled depth (42 m borehole breakout length; a few in the Wildegg Formation but most of these in the Upper Dogger above the Opalinus Clay). This local SH orientation is not resolved in the model results.

One possible explanation of this SHmax rotation is the existence of a backthrust that is cut by the Weiach well at that depth where SHmax is rotated counterclockwise from the regional trend. If this is the explanation then it is not resolved in the model due to limited geometry resolution. The rotation of SHmax outside the model area that is observed in a few other wells (Herdern, Zürich; see NAB 12-005) cannot be discussed in the context of the model.

3) The mechanical parameters were estimated on the basis of geophysical logs and geomechancial test results. The quoted reports can be downloaded from the Nagra website, but unfortunately they are in German: http://www.nagra.ch/en/downloadcentre.htm

It is noted that apart from the Dogger and lower Malm formations, there is only very limited geomechanical test results available. The geomechanical units in the model are considered as homogenous whereas in reality significant heterogeneity is expected (inter-layering in clastics, variable structural disturbance), and the effect of this heterogeneities can differ in different formations. E.g. existing fractures would mostly impact on the strength parameters and less so on the stiffness parameters, and the strength decrease would be more relevant for hard rocks (limestones and cemented sandstones) than for claystones.

The definition of homogeneous geomechanical units and assignment of the mechanical parameters is obviously a strong simplification, but considered appropriate for the scale of investigation. The relevant feature as shown in the model results is that the argillaceous units (e.g. Opalinus Clay) are of lower strength and stiffness than e.g. the limestone. Hence the relative values in the sedimentary sequence is of key importance, not the absolute values. The impact of strength variation (similar to stiffness variation) is currently being explored in similar modelling runs.

4) SH and Sh magnitudes of the initial stress state are similar which is indicated by the somewhat incoherent orientation of SH (Fig. 9a) and tectonic regime (Fig. 9c).

One way to enlarge horizontal differential stresses is shortening in SH direction and extension perpendicular to that direction, with shortening being greater than extension because the k ratio shall increase according to the data. The boundary conditions have been chosen simple with north-south shortening and east-west extension which is reasonable considering the northward directed push the sediments have experienced north of the convexly shaped Alps. For more detailed boundary conditions there is no observational basis as geodetic data are inconclusive due to uncertainties being larger than displacement rates. Another reason for chosing these rather simple boundary conditions is that they are used to account for tectonic loading which represents the overall deformation over a long time span, whereas contemporary site-specific observations over a few years could be misleading.

5) We introduced a new section 3.1 including a new Fig. 10 showing the displacement field of the base model.

Displacement field of the base model The Siglistorf anticline shows left-lateral offset that increases towards the surface, while the Stadel-Irchel Anticline shows right-lateral offset (Fig. 10). This means extrusion of the block in between the SAe and the SIA to the east, relative to the adjacent blocks in the north and south. Horizontal slip correlates with dip of the SA i.e. large offset at steep portions of the fault and small offset at low-angle dip (Fig. 10). The SA and SIA show thrust faulting and thereby accommodate N-S shortening (Fig. 10). Uplift occurs throughout the whole model area (Fig. 10) due to the push from the south. Uplift increases towards the surface, but also piece-wise from the southern model boundary towards the SIA, from the SIA to the SA and from the SA to the northern model boundary (Fig. 10). Note that the modelled amount of displacements does not mean total displacement during the geological past. Displacements within the model area can be understood in relation to the amount of displacement at the model boundary. If an assumption would be made in what period of time the displacements at the model boundaries would occur one would get displacement rates.

Caption Fig. 10 new: Fig. 10: Displacements. EW (left column), NS (middle column) and vertical displacements (right column) in vertical EW (top row) and NS (middle row) profiles through the Weiach well and in the middle surface of the Opalinus Clay (bottom row). Thin lines denote the location of the profiles.

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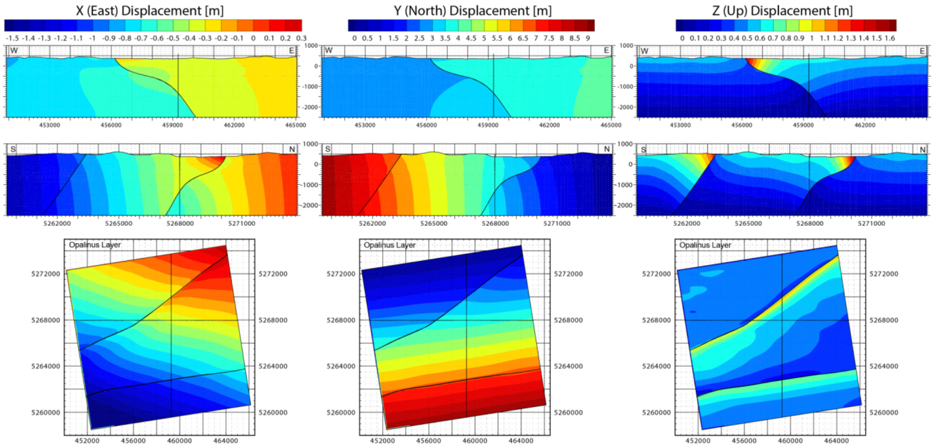
X (East) Displacement [m]
-1.5 -1.4 -1.3 -1.2 -1.1 -1 -0.9 -0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3
Y (North) Displacement [m]
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9
Z (Up) Displacement [m]
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6
W
E
S
N
1000
0
-1000
-2000
453000
456000
459000
462000
465000
5262000
5265000
5268000
5271000
Opalinus Layer
5272000
5268000
5264000
5260000
452000
456000
460000
464000

Fig. 1.