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Interactive comment on "3-D geomechanical modelling of a gas reservoir in the North German Basin: workflow for model building and calibration" *by* K. Fischer and A. Henk

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We thank all referees for the thorough reviews of the paper, constructive criticism and positive feedback. In the following, all comments and questions are addressed individually.

C. Bücker: The dataset used in this study was indeed extensive, in particular regarding local stress measurements for calibration. However, data on rock mechanical properties (especially static laboratory measurements for calibration of the dynamic properties) could have been more extensive as the geomechanical modeling approach is open to incorporate a more detailed mechanical stratigraphy. Application of refined pa-

rameters in submodels in combination with lateral variations in rock properties would be the next natural steps to further improve the modeling results.

D. Tanner: We agree with the reviewer's suggestion to reverse the sequence of case study and workflow in the title as most of the paper deals with methodological aspects. The revised title is 'A workflow for building and calibrating 3D geomechanical models - a case study for a gas reservoir in the North German Basin'.

Regarding the two specific comments: (1) 'recent' will be replaced by 'present-day' to be more precise. (2) This sentence is clarified. In fact, almost all faults comprised in the geological model are transferred to the geomechanical model and no pre-selection was done. Only those very far from the production area or very small conceptual faults inferred from reservoir simulation are neglected.

The English corrections are very welcome and are all considered in the final version of the manuscript.

M. Alber: Concerning the questions raised:

(1) In order to generate the magnitudes of minimum and maximum horizontal stress of about 70-100MPa at the reservoir level, inward-directed displacements of about 80-180m are required, respectively. The exact values depend of course on the lateral dimensions of the load frame, which in our case is quite large (130 km x 130 km). These displacement boundary conditions are applied symmetrically on the opposing sides of the load frame.

Direct application of stresses as lateral boundary conditions would require a fixation of the bottom nodes in all directions for numerical stability. This would result in turn in inhomogeneous stresses along the boundaries towards the bottom of the model. Lateral displacements yield an absolute homogeneous stress field and the bottom nodes only

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have to be fixed in vertical direction.

(2) The present geomechanical model includes the elastic moduli of Young's modulus and Poisson's ratio only. Strength parameters can be assigned to directly simulate plastic deformation. Reservoir-specific information on the applied elastic moduli is taken from the provided results of rock mechanical tests on drill cores and correlated geomechanical sonic logs (DSI®).

(3) Model calibration represents the comparison of modeling results to field observations. Present-day stress measurements can be used to calibrate so-called static geomechanical models, which focus on revealing the specific present-day stress distribution. In case paleo-stress distributions are considered by the model, the respective results can be compared to fracture information of corresponding times, since fracture orientation reflects the stress field prevailing during their formation.

E. Stein: As most of the remarks focus on the proportions of workflow and case study, the change in title (see above) will satisfy them by putting the paper into a better perspective. In this way, it is clarified that the workflow represents the major outcome of the project and that is approved by application to the case study reservoir.

The mentioned lack of real field data is apparently a misunderstanding. The data base of the case study is of course real and quite good (see comments of reviewers C. Bücker and D. Tanner). As it is pointed out in the paper the precise topology of the reservoir horizon of the case study, as well as the specific network of more than 80 faults, is transferred and embedded in the geomechanical model (p.777). Furthermore reservoir-specific material properties from provided results of rock mechanical tests and geomechanical sonic logs are mentioned to have been applied. Real field data was thus the core of testing the workflow application.

Interactive comment on Solid Earth Discuss., 5, 767, 2013.