Reply of RC1

Thanks for the comments.

1. The cross section for global structure is parallel,why? is it sufficient for the reproduction of the characteristics .In another direction,the structure may be different, how to reproduce in 3D space with DANN? please clarify

Response:

In many cases, 3D model is constructed with parallel cross-sections. Therefore, we provide a real case with parallel cross-sections in this study. However, as you pointed out, the parallel cross-sections cannot sufficient information to reproduce structures in the other direction. Therefore, as shown in the example in section 4.2, seven non-parallel trenches are used as data source for modeling. In the proposed method, whether the cross-sections used for modeling are parallel or not is not a key issue.

In this study, the modeling area is partitioned into regular grids. Then, the core of modeling is to specify the geological attribute on each grid. To simplify the problem, geological objects are formed with closed surfaces, which the same attribute appear in it. So, the problem is transferred into obtaining the elevation of subsurface as the interpolation process.

Here, the objective function of the DANN is constructed with the elevation of subsurface. Note that each object has two networks for top surface $M_{\max}(i)$ and bottom surface $M_{\min}(i)$. Values of the top surface $H_{\max}(Att_i)$ and bottom surface $H_{\min}(Att_i)$ are normalized and used as training dataset to learn the spatial distribution of geological surfaces. Here, coordinates (x, y) of the simulation grid are the input data, and the corresponding elevations $h_{\max}(x, y, Att_i)$ and $h_{\min}(x, y, Att_i)$ of each geological attribute are labeled for training $M_{\max}(i)$ and $M_{\min}(i)$.

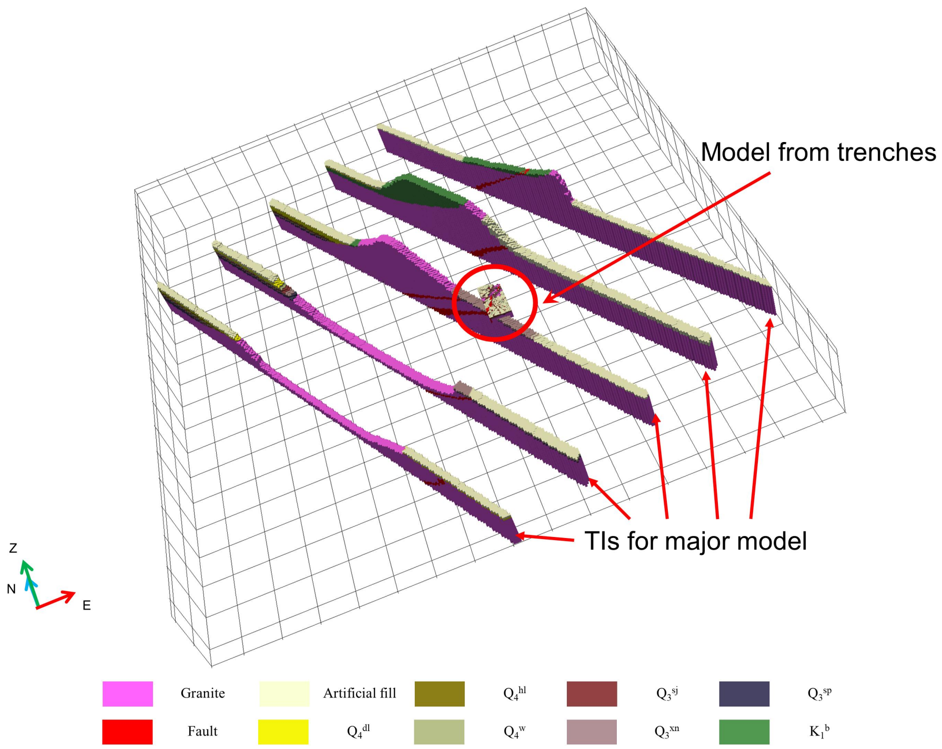
The DANN is trained with the depths of contact lines from the cross-sections. Then, the elevations $h'_k(x, y, Att_i)$ of the top and bottom surface of the *Att*$_i$ are predicted when the coordinates of grids to be simulated are input into the $M_{\max}(i)$

and $M_{\min}(i)$. After completing the traversal, the top and bottom surface of each attribute can be obtained.

2. The small structue is reproduced with the constrain of trenches to update the initial global structure. is it a 3D template for comparison.How to guarantee the consistency between the global stuctures and the local trenches. May be an illustration is needed.

Response:

The two models are independently built by the presented method, although they are in the same area (shown in the followed figure). The model with trenches are not constrained by the global model. Two trenches of BTI2 and BTI3 crosses the TI3 for the major model. In these two cross positions, the geological contacts are consistent in the trenches and parallel cross-sections. Because the TIs and BTIs are hard data for the modeling, the geometries of the two model in the cross positions are kept consistency.



3. In line 261-263. the method of constructing 3D models from 2D training image isstudiedï¼ So maybe a revised depiction is suitable.

Response:

As pointed out in lines 261-263, the 2D TIs cannot provide information in third dimension. In this study, to obtain 3D patterns for modeling, we provided a compromise way by expanding 2D images to 3D data rather than directly extract 2D patterns for constructing 3D structures. The detail process of expansion is provided in lines 265-286. To express the process clearly, here, a simple process is given as follow:

(1) The first step is defining an expansion area $Buff_{sec}$ with or bigger than a template size in the simulation grid (SG), in which the 2D TI is in the middle or on the boundary. The position of $Buff_{sec}$ depends on the location of 2D TI.
(2) A grid node neighboring to the known data or to the node with appointed data is randomly selected and marked as the current access grid node u_c in the lateral layer. The attribute that appears with the maximum number in the moving window of 3×3 grid nodes of which the center node is u_c is assigned to the attribute value of u_c.
(3) Repeating step (3) until to values of all grids are assigned in $Buff_{sec}$ layer by layer, the 3D TD with a template size is obtained.

Note that the presented method is implemented with multiple scales. Therefore, in each scale, the 3D TD should be constructed before simulation.