Estimation of subsurface stress from seismic data: A feasibility analysis

Xin Liu, The University of Texas at Austin

ABSTRACT

I demonstrate the feasibility of estimating subsurface stress from seismic data with a sensitivity test and seismic inversion for some simple models. I propose a workflow, which consists of four steps (Figure 1): Step 1: initialize a stress model based on geomechanical modelling or geological information; Step 2: calculate elastic anisotropy parameters from the stress-stiffness relationship obtained from my previous work; Step 3: synthesize seismic data and compute the misfit between the observed data; Step 4: if the misfit is small or converged, output the stress state as the final stress, otherwise, go back to step 1 and update the stress model and repeat this workflow until the misfit converges.

I conduct seismic data-based stress estimation on some simple models. This test is made up of four steps: 1) generate a shot-gather as the observation (field seismic data); 2) generate a series of shot-gathers with different stress states; 3) compute the root mean square difference (misfit) between each of the shot-gathers and the observation; 4) generate a contour plot of the difference. Figure 2 demonstrates the difference contour plot and the Very Fast Simulated Annealing (VFSA) method inversion results. The synthetic model inversion demonstrates the feasibility of estimating subsurface from seismic data. In my future work, I will utilize parallel computing for stress estimation on complicated models.

CLICK ON IMAGE FOR LARGER VIEW

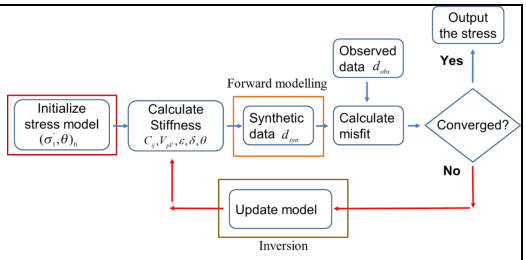

Figure. 1: Proposed workflow for seismic data-based subsurface stress inversion.

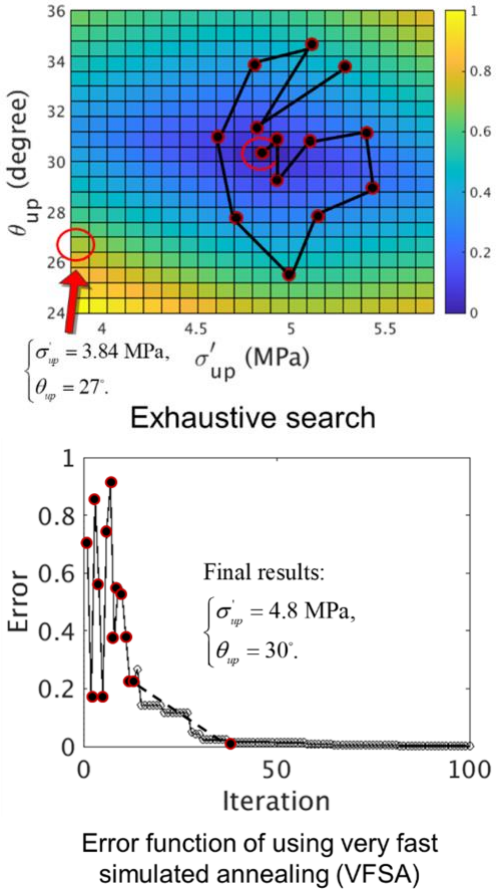

Figure 2: Exhaustive search and VFSA results for seismic data-based stress inversion on a two-layer model.

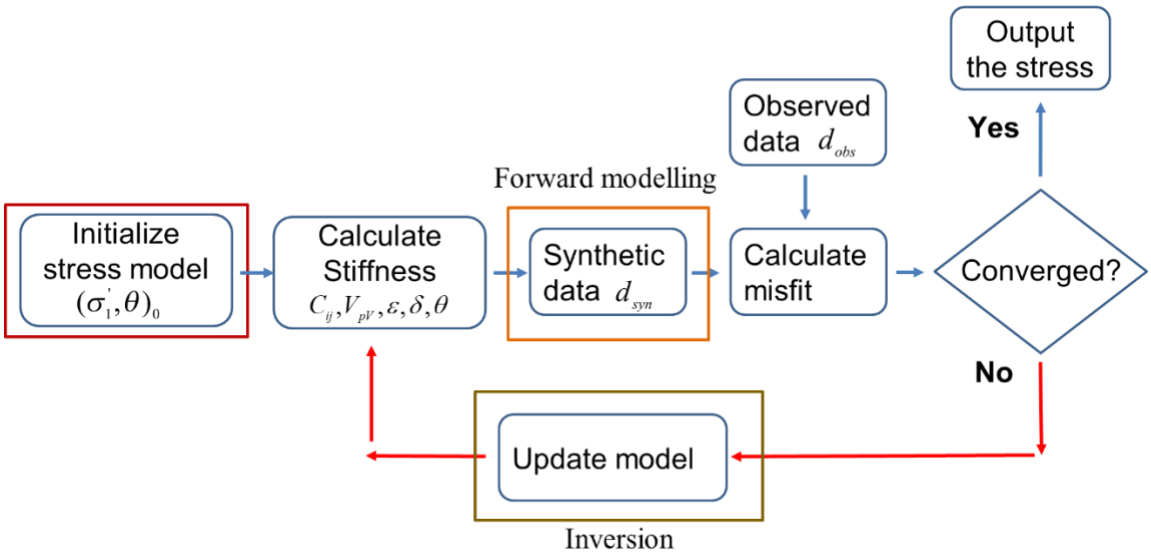

Figure 1: Proposed workflow for seismic data-based subsurface stress inversion.

Back

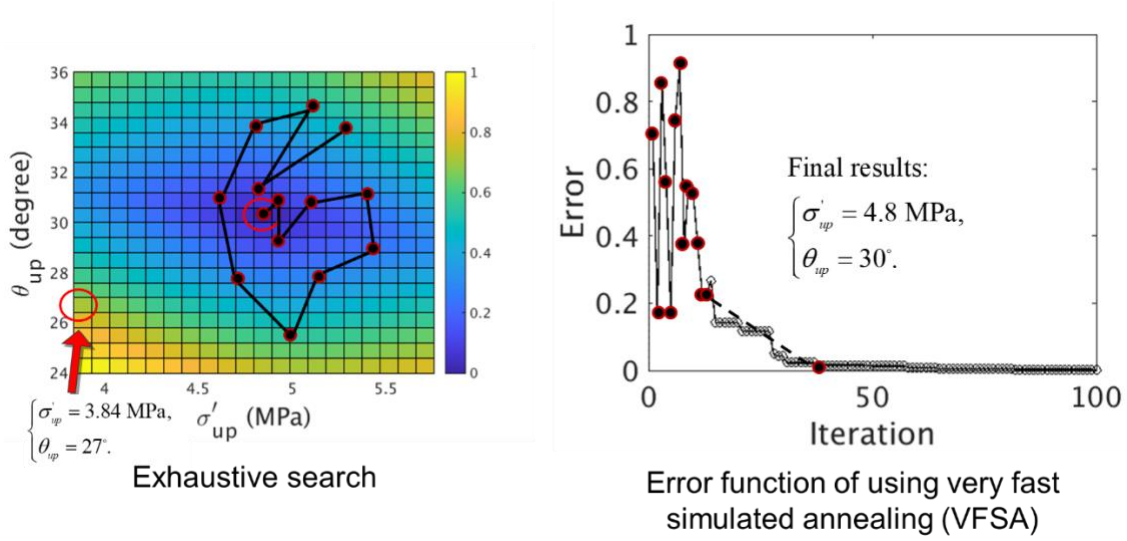

Figure 2: Exhaustive search and VFSA results for seismic data-based stress inversion on a two-layer model.

Back