

Stress Shadowing – modelling the effect of well and stage spacing on the induced stress field



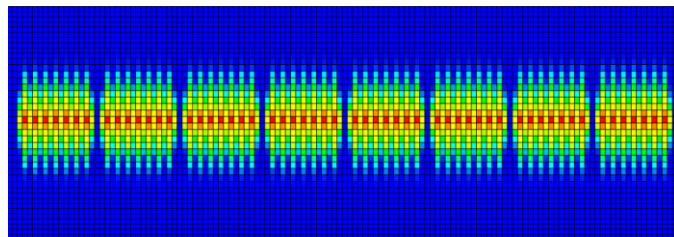
6X: Using the full stress tensor to predict stress shadowing

Stress shadowing occurs when the induced stress field from the hydraulic fracturing of one stage influences subsequent stages. For this to occur the stages need to be sufficiently close for the induced stress field to propagate to the next stage. The closer the stages the more pronounced the effect is likely to be.

To model stress shadowing the simulator needs to include a geomechanics model. It turns out that this model should solve at least for the normal stress tensor components, rather than just the hydrostatic mean stress. The 6X simulator has this capability.

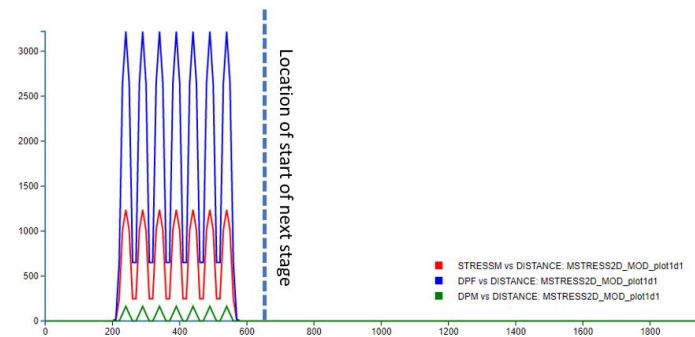
Solving only for mean stress

The simplest geomechanics model in 6X solves only for the average of the normal stress tensor components (the mean stress). Using this model for a single well study with close stage spacing we see no stress shadowing effect. The figure below shows the dynamic permeability induced by the fracturing of 8 consecutive stages. Clearly, each stage shows



the same pattern of SRV generation regardless of the stress field generated by the previous stages.

To understand why this happens we plot the mean stress field along the path of the well just before the start of injection into stage 2

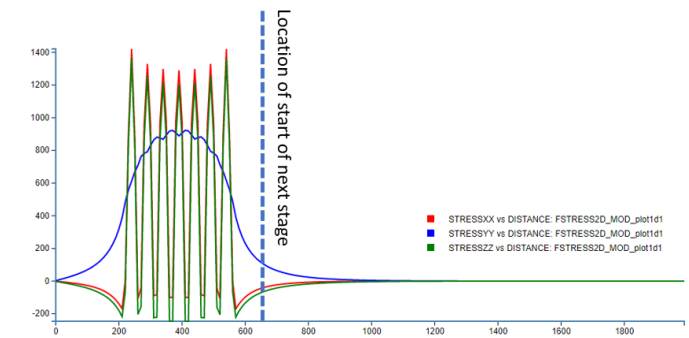


The plot shows that the mean stress (red) is simply a multiple of the fracture pressure (blue) and matrix pressure (green). Since neither of these properties have significant values at the location of the second stage (dotted blue) there will be no stress shadowing effect modelled.

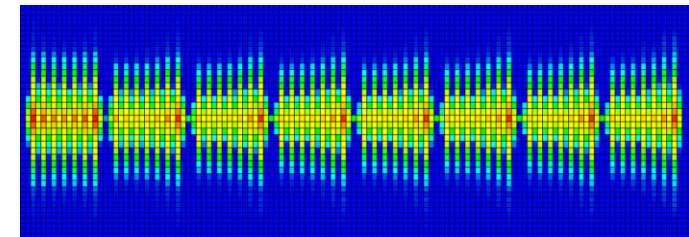
Solving for the full stress tensor

6X also has a more advanced geomechanics model, which can solve for each individual component of the stress tensor and use these values to predict the rock breakage in more detail. Using this model and plotting the normal stress tensor

components along the well trajectory before the start of stage 2 we see an interesting effect.



The individual normal stress components are non-zero at the location of the next stage, despite the fact that they sum to zero, giving zero mean stress. Consequently we can expect stress shadowing effects when taking account of these components. The plot below shows the dynamic permeability, which clearly shows the influence of the stress field on subsequent stages.



Use the 6X full stress tensor option to understand the effect of previous stages and nearby wells on the development of the SRV.