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The stress state in the shallow Paris basin: a case study

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The Paris basin is characterized at depths ranging from 350m to 750m by a shale layer set in between more competent limestone layers. The stress state in each of the layers is different from one another such that it is not possible to derive the stress in one layer knowing the two others. It seems that the shales from the basin effectively decouple the stresses in the two limestone formations.
We use MILAMIN, a fast-finite element code, to reproduce the stress situation observed nowadays in the Paris basin. Based on the tectonic history, we assume that no far field processes are driving the stresses in the Paris basin and that only gravity is active. Assigning visco-elastic parameters to the three different layers we show that using time dependent constitutive laws we can reproduce the current stress situation. Explaining the stresses in the light of visco-elasticity is comforted by the absence of deviatoric stresses in the shale layer, which is characteristic of a relaxation mechanism. This study case shows that stresses are not necessarily in a critical state in the underground but that the rheology of the rocks can actually govern the current stress state. The relatively small relaxation time of shales means that it is especially important to take their visco-elastic behavior into account if one wants to understand the current stress situation in any region.