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Pressure build-up and stress variations within the Earth's crust in the light of analogue models

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Strength contrasts and spatial variations in rheology are likely to produce significant stress differences in the arth's crust. The buildup and the relaxation of stresses have important consequences for the state of stress of the brittle crust, its deformational behaviour and seismicity. We performed scaled analogue experiments of a classic wedge-type geometry wherein we introduced a weak, fluid-filled body representing a low-stress heterogeneity. The experiments were coupled to direct pressure measurements that revealed significant pressure differences from their surrounding stressed matrix. The magnitude of the pressure variations is similar to the magnitude of the differential stress of the strongest lithology in the system. When rocks with negligible differential stresses are considered, their pressure can be more than twice larger than the surrounding lithostatic stress. The values of the pressure variations are consistent with the stresses that are estimated in analytical studies. This behaviour is not restricted to a particular scale or rheology, but it requires materials that are able to support different levels of stress upon deformation. For non-creeping rheological behaviours, the stress and pressure variations are maintained even after deformation ceases, implying that these stress variations can be preserved in nature over geological timescales.