Using structural frames to integrate structural geology into implicit 3D modelling

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Implicit geological modelling allows for observations of surface location and orientation to be interpolated into continuous 3D surfaces. These surfaces are usually built by finding a function that minimises the misfit between the surface and observations (gradient or value of the implicit function) combined with a regularisation constraint that controls how the surface develops between observations. When modelling complex terranes such as fold series, fault networks or intrusions it is usually necessary to use interpretive constraints for creating the expected geometries. These interpretations are problematic, as the constraints are usually not observations but realisations of the geologists’ subjective interpretation, and are therefore difficult to change and interrogate to better understand the geometry. Recent developments for implicit modelling of folds and faults have built new local coordinate systems using the structural geology of the object being modelled and are termed structural frames. For example, for folds, the structural frame is aligned to the axial surface of the fold and fold axis. For faults, the structural frame is aligned to the fault surface and slip direction. Using structural frames, conceptual models of the fold and fault geometries can be combined with the observations of the surfaces. This means that rather than using the geologists’ subjective interpretation to constrain the model geometries, the conceptual model can guide the interpolation where observations are missing. Geological uncertainties in the resulting geometries can be assessed by framing the modelling as an inverse problem and varying the conceptual model parameters to fit the geological observations. In this contribution, we review the use of structural frames for constraining 3D geometry of structurally complex terranes and provide an example of a faulted fold series.