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3D geomodelling in the complex metamorphic and poly-deformed units of the Italian Western Alps (Conca di By, Aosta Valley, Italy)

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3D geological modelling of complex metamorphic terrains that underwent a sequence of ductile and brittle deformation events is an extremely challenging task. Difficulties start from the input data that are frequently sparse and heterogeneous in quality and distribution. In projects based on field data only (without significant subsurface data) uncertainties are even more pronounced, but, in our project, we had the rugged topography of the Western Alps on our side, with elevations ranging from c. 1200 m to c. 3200 m and very continuous outcrops. Other problems, that we address in this contribution, arise during the modelling process. We tested different commercial software packages and some open-source research libraries and we found that no one is capable of modelling our complex structures out-of-the-box. This is not surprising since generally these codes, and particularly the commercial ones, are geared towards modelling gently deformed sedimentary sequences. However, it is possible to overcome a large range of obstacles by “fooling” implicit structural modelling algorithms, simply “cheating” on the geological meaning of model entities. This means (1) developing a conceptual model of polyphase ductile and brittle deformation, (2) finding geological/mathematical entities that are at the same time implemented in the code and able to represent the complex structures, and finally (3) carrying out the implicit modelling. For instance, tectonic contacts between large-scale tectono-metamorphic units can be treated as unconformities (and not as faults) to obtain a realistic representation. In some cases, also conformal lithological boundaries can be considered as unconformities with the goal of allowing larger thickness variations. In other situations, a “fake” stratigraphy where the same units are repeated several times can be used to model sequences of isoclinal folds and thin tectonic slices. In this contribution, some of these modelling solutions are compared in terms of (1) their straightforward implementation, and (2) their ability to generate models that properly fit the very detailed geological maps available in our study area (c. 60 km^2 mapped at 1:5.000-1:10.000 with a dense set of structural stations).