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3D modelling of the Austroalpine-Penninic collisional wedge of the NW Alps: dataset management and preliminary results

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We know since the beginning of the 20th century, thanks to mapping and structural studies by the Italian Regio Servizio Geologico (Franchi et al., 1908) and Argand's work (1909; 1911; 1916), that the Austroalpine-Penninic collisional wedge of the NW Alps is spectacularly exposed across the Aosta Valley and Valais ranges (Italy and Switzerland). In the 150th anniversary of the first ascent to Ruskin's "most noble cliff in Europe" - the Cervino/Matterhorn (Whymper, July 14th 1865), first described in a geological profile by Giordano (1869) and in a detailed map by Gerlach (1869; 1871), we have seen the conclusion of very detailed mapping projects carried out in the last years over the two regions, with collaborative efforts across the Italy-Switzerland border, constellated by 4000 m-high peaks. These projects have pictured with an unprecedented detail (up to 1:10.000 scale) the geology of this complex region, resulting from pre-Alpine events, Alpine subduction- and collision-related ductile deformations, and finally late-Alpine brittle deformations from the Oligocene to the Present.

Based on this dataset, we use up-to-date technology and software to undertake a 3D modelling study aimed at: i) reconstructing the 3D geometry of the principal tectonic units, ii) detecting and unravelling problems and incongruences in the 2D geometrical models, iii) modelling the kinematics of the Oligocene and Miocene brittle fault network using 2D and 3D balancing and palinspastic restoration techniques.

In this contribution we mainly discuss the prerequisites of the project. Common geomodelling paradigms (mainly developed for the hydrocarbon industry) cannot be applied in this project due to (i) the little scale, (ii) the source of the data – fieldwork, and (iii) the polyphase ductile and brittle deformations in the metamorphic nappe stack. Our goals at the moment are to model the post-metamorphic fault network and the boundaries of the principal tectonic units, which will be considered as a sort of pseudo-stratigraphy, since they are the oldest feature that can be traced continuously at the map scale. For this reason we have developed a set of attributes identifying the tectonic and lithological units (a "legend"), implemented both in the GIS database and in the 3D models, which at the same time is compatible with the data structure of 3D modelling packages like Move and Skua/Gocad, and allows tracing the complex hierarchic classification of the units mapped in the GIS. This allows for the almost automatic and consistent two-way transfer of data between the GIS and geomodelling environments. E.g. results of 3D modelling, which is based on input data originally stored in the GIS, will eventually be transferred back to the GIS.

The results of this study, which are preliminarily presented here, will open new opportunities to study the collision- and subduction-related nappe architecture and kinematics with younger deformations removed, and will eventually lead (with additional studies) to a step-by-step retrodeformation supported by modern technologies, following the path traced by Argand at the beginning of the 20th century.

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