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Controls of the collisional architecture in an evaporite-bearing fold-thrust wedge: the central Northern Calcareous Alps

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Fold-thrust wedges are common in external sectors of orogens and include strongly imbricated thin-skinned cover strata, ramp-anticlines, and show generally a forward dip of the wedge surface and an orogen-ward base of the orogenic wedge. The shape and internal structure are controlled, e.g., by the presence of rheologically weak layers (evaporites, clay) at the basal decollement and its coupling and the flexure of the underlying lower-plate crust. To study individual contributions to these effects, we investigated the N–S Osterhorn–Werfen Imbricate zone (WIZ) section across the central Northern Calcareous Alps (NCA), which exposes a flat-lying thrust-fold wedge. The principal goals of this contribution are threefold: (1) Based on industrial reflection seismic lines calibrated by few deep wells and field work, we examine the structure of the Osterhorn-WIZ section. (2) We examine the role of uppermost Permian to Lower Triassic evaporite mélange (Haselgebirge Fm.). (3) Finally, we propose several key stages for the tectonic evolution of the central NCA.

A dense net of reflection seismic lines (OMV AG) was investigated within a project between 2016 and 2019. From north to south, the lines allow to deduce four major sectors in the Osterhorn–WIZ section: (i) The Osterhorn Mts. are composed of the flat-lying Tirolic Osterhorn unit, which is affected by gentle km-scaled folds implying NE–SW shortening and small-scale NNW-trending normal faults due to ENE–WSW extension. In well Vordersee 1, the underlying Bajuvaric Nappe (BN) includes Paleogene and Jurassic lithologies indicating thrusting during late Paleogene. The BN is underlain by the Rhenodanubian Flysch zone, which reaches the latitude of the antiformal Strobl window in the eastern Osterhorn Mts., the reflective Subalpine Molasse, and, over wide portions, by the autochthonous Mesozoic cover on the European plutonometamorphic basement. (ii) The southern margin of the Osterhorn unit is well expressed by losing internal consistency of seismic reflections, and a faulted pattern appears with short N-dipping reflectors. Both reverse and normal faults indicate ca. top-N indentation. (iii) A W–E seismic section (Lammer valley), calibrated by well Golling Thermal 1, includes typical Tirolic strata in upper portions and is very reflective down to ca. 10 km. Small internally transparent evaporite-like lenses are rare. Consequently, uppermost reflectors could be interpreted as Rossfeld and Dachstein Fms. as the southern extension of the Tirolic Osterhorn unit. This finding implies that the Schwarzer Berg unit of the Lammer Mass can be interpreted as a tectonic nappe with Haselgebirge at its structural base. (iv) The Abtenau–St. Martin N–S section shows the transition between the N-dipping, S-vergent thrusts of the WIZ underneath the Tennengebirge to the Haselgebirge in the north. Rocks of the Tennengebirge unit never reach a subsurface level in this section. The WIZ includes small transparent lenses interpreted as evaporites here combined with surface exposures of Triassic pelagic limestones of the classical Lower Juvavic nappe. At the southern end, the N-dipping pre-Permian Graywacke zone basement is underlain by two triangular structures interpreted as indenting Lower Austroalpine and Penninic basement-cover triangle structures. These indentors and the WIZ imply late Paleogene décollement, internal shortening and surface uplift of NCA also supported by Neogene apatite (U-Th)/He ages.

Session: *Pangeo workshop: Regional Geology*
Keywords: *Orogeny, Passive continental margin, Extension, Thrusting, Tectonic Inversion, Evaporite Tectonics*