Morcles fold nappe in western Switzerland plunges to the ENE whereas the fold axes in the more eastern Doldenhorn nappe plunges to the WSW. These opposite plunge directions characterize the Wildstrubel depression (Rawil depression). The Morcles nappe is mainly the result of layer parallel contraction and shearing. During the compression the massive limestones were more competent than the surrounding marls and shales, which led to the buckling characteristics of the Morcles nappe, especially in the north-dipping normal limb. The Doldenhorn nappe exhibits only a minor overturned fold limb. There are still no 3D numerical studies which investigate the fundamental dynamics of the formation of the large-scale 3D structure including the Morcles and Doldenhorn nappes and the related Wildstrubel depression. We study the 3D evolution of geometrical instabilities and fold nappe formation with numerical simulations based on the finite element method (FEM). Simulating geometrical instabilities caused by sharp variations of mechanical strength between rock units requires a numerical algorithm that can accurately resolve material interfaces for large differences in material properties (e.g. between limestone and shale) and for large deformations. Therefore, our FEM code combines a numerical contour-line technique and a deformable Lagrangian mesh with re-meshing. With this combined method it is possible to accurately follow the initial material contours with the FEM mesh and to accurately resolve the geometrical instabilities. The algorithm can simulate 3D deformation for a visco-elasto-plastic rheology. Stresses are limited by a yield stress using a visco-plastic formulation and the viscous rheology is described by a power-law flow law. The code is used to study the 3D fold nappe formation, the lateral propagation of folding and viscoplastic necking from an initially localized perturbation and also the lateral propagation of cusps due to initial half graben geometry. Thereby, the small initial geometrical perturbations for folding and necking are exactly followed by the FEM mesh, whereas the initial large perturbation describing a half graben is defined by a contour line intersecting the finite elements, where more numerical integration points are applied.

## Micro-seismic characterization of the Fribourg Lineament - Switzerland

Vouillamoz, N.[1], Abednego, M.[1], Deichmann, N.[2], Wust-Bloch, H.G.[3] & Mosar, J.[1]

[1] University of Fribourg, Departement of Geosciences, Earth Sciences, Chemin du Musée 6, CH-1700 Fribourg, Switzerland
(martinussatiapurwadi.abednego@unifr.ch, naomi.vouillamoz@unifr.ch, jon.mosar@unifr.ch).
[2] Schweiz. Erdbebendienst (SED), Sonneggstrasse 5, CH-8092 Zürich, Switzerland
[3] Tel Aviv University, Department of Geophysics and Planetary Sciences, P.O.B. 39040, Tel Aviv, 69978, Israel

This analysis investigates low-magnitude seismicity generated within the Fribourg area (Western Molasse Basin (WMB) - Switzerland). It focuses on the Fribourg Lineament (FL), an alignment of weak seismicity that showed recent signs of increased activity (KASTRUP et al., 2007). The FL runs in a North-South direction east of the city Fribourg and is parallel to the Fribourg syncline. Orientation of these two features differs strongly from the surrounding tectonic structures that show a general SW-NE trend.

The FL has been monitored since 2010 by two sparse mini-arrays (seismic navigating systems - SNS). Each SNS consists of one central 3D short-period (1Hz) sensor surrounded by three 1D short-period (1Hz) sensors. They are deployed in a tripartite geometry with an aperture of 100 m, which is best suited for azimuth and apparent velocities determination of incoming signal (JOSWIG, 2008). The recordings of the two SNS are complemented by records of three permanent stations of the Swiss Seismological Service (SED).

Event detection is done by visual event screening of continuous data sonograms (SICK et al., 2012). Sonograms are spectrograms based on power spectral density (PSD) matrix, noise adapted, muted and pre-whitened. Special features of sonograms allow for the extraction and recognition of earthquake signals by visual pattern recognition near to 0 dB signal to noise ratio. Detected events are then located using HypoLine, a software especially designed for SNS. Event location is done interactively whereby simulation results are immediately updated after every single parameter change. This enables to optimal use of prior information, such as geological knowledge, when determining hypocenter location in the multiple probable solutions (JOSWIG, 2008). Both the densification of the seismic sensors around the FL and the increased detection power of sonogram analysis permits lowering the detection threshold of the Earthquake Catalog of Switzerland (ECOS) by about one order of magnitude in the FL area. Our comprehensive catalog of earthquakes detected within the FL after 2010 comprises more than 200 events.

A set of seismic lines interpreted by InterOil was used to build a 3D structural model of the WMB. Fault planes have been extrapolated to the surface across five horizons from top basement to base of the Tertiary cover. An initial analysis of our seismic catalog shows that most of the local micro-seismicity is located in the sedimentary cover. Some events are collocated with interpreted structures; however, an important part of the seismicity is located in areas without known substructures (due to the lack of seismic lines). Since many earthquakes have similar origins over time, signal cross-correlation is used for collocation purposes and in order to identify possible fault zones.

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## Provenance analysis and paleogeography of the Gosau Group (Upper Cretaceous - Paleogene) in eastern Austria and western Slovakia

Wagreich, M. & Hofer, G.

Department of Geodynamics and Sedimentology, University of Vienna, Althanstrasse 14, A-1090 Vienna, Austria
(michael.wagreich@univie.ac.at, gerald.hofer@univie.ac.at)

The Upper Cretaceous to Paleogene sediments of the Gosau Group of the Northern Calcareous Alps (NCA) are unconformably and diachronously overlying folded and faulted Permian to Cretaceous units. Various Gosau Group deposits representing different basins are exposed at the eastern part of the Eastern Alps (Austria) at the south-western margin of the Vienna Basin, and at the western part of the Western Carpathians (Slovakia). In between, NE-SW-striking Gosau sediments are drilled in several wells below the Neogene fill of the Vienna Basin. The Gosau deposits were folded during the Alpine orogeny, and today form structurally complex synclines. From north to south several synclines on different tectonic units of the NCA and on Carpathian units are present: the northernmost Gießhübl Syncline, the Prottes Gosau Group, its Slovakian equivalents of Studienka and Brezová, the Glinzendorf Syncline and the southernmost Grünbach Syncline.

About 250 fine-clastic samples from outcrops, drill cores and cuttings of various Gosau locations and formations have been geochemically analyzed (bulk rock). Additionally, heavy mineral contents of coarse-clastic sediments (523 samples) have been evaluated and more than 600 grains of garnet, chromian spinel and tourmaline have been analyzed by electron micro probe with the aim to reconstruct the hinterland of the Gosau sediments and to distinguish different Gosau basins and to decipher the paleogeographic evolution in this area.

A general trend from chromian spinel dominated heavy mineral spectra of the Coniacian to the Campanian/Maastrichtian to a garnet dominated up to the Paleogene (plus relatively high amounts of tourmaline within the Slovakian Studienka area) can be observed for all Gosau deposits. Almandine is generally the dominant garnet component. Only Coniacian to