



## **Permian magmatism, Permian detachment faulting, and Alpine thrusting in the Orobic Anticline, southern Alps, Italy**

Florian Pohl, Niko Froitzheim, Thorsten Geisler-Wierwille, and Oliver Schlöder  
Steinmann Institute, University of Bonn, Germany

The Grassi Detachment Fault is located in the Orobic Alps east of Lake Como and was described by Froitzheim et al. (2008) as an Early Permian extensional structure. Many issues still remained unclear, like the exact timing of faulting and the extension from the well-exposed part of the detachment towards west. The Grassi Detachment Fault separates the Variscan Basement in its footwall from the volcanic and sedimentary rocks of the Early Permian Collio Formation within its hanging wall, marked by a mylonitic and cataclastic layer whose textures indicate top-to-the-southeast displacement. The footwall basement is formed by the Variscan Morbegno Gneiss and two granitic intrusions, the Val Biandino Quarz Diorite (VBQD) and the Valle Biagio Granite (VBG). The former is syntectonic with respect to the detachment, whereas for the latter, the relation to the detachment is unknown. The age of the VBQD is poorly defined as  $312 \text{ Ma} \pm 48 \text{ Ma}$  (Thöni et al. 1992); the VBG has not been dated. Volcanic rocks of the Collio Formation in the hanging wall may represent the extrusive part of the magmatic system.

In our study area west of Val Biandino, several faults and shear zones are exposed: (1) The Grassi Detachment Fault is represented by mylonites and cataclasites with top-SE shear sense, between basement rocks and the Collio Volcanics. Towards NW, it is truncated by the unconformably overlying Late Permian Verrucano Lombardo. This may reflect the eroded culmination of a Permian metamorphic core complex. (2) A steeply NW-dipping, brittle normal fault is found further west in the footwall between VBQD and VBG. It is sealed by the basal unconformity of the Verrucano Lombardo and therefore should also be of Early Permian age (Sciunnach, 2001). It may represent an antithetic fault with respect to the detachment, accommodating the uplift of the magmatically inflated core complex. (3) The Biandino Fault is a steeply SE-dipping reverse fault, affecting also the Late Permian Verrucano Lombardo. It is therefore an Alpine structure. (4) Several south-directed Alpine thrusts duplicate the lithostratigraphy, including the detachment, and are related to the Orobic thrust further north. They also offset the Biandino Fault.

U-Pb zircon ages measured with LA-ICP-MS (work in progress) will further clarify the temporal relations between the intrusions, volcanics, and the shear zones.

Froitzheim, N., Derks, J.F., Walter, J.M. & Sciunnach, D. 2008. Evolution of an Early Permian extensional detachment fault from synintrusive, mylonitic flow to brittle faulting (Grassi Detachment Fault, Orobic Anticline, southern Alps, Italy) *Geological Society, London, Special Publications*, 298; 69-82. doi:10.1144/SP298.4

Thöni, M., Mottana, A., Delitala, M. C., De Capitani, L. & Liborio, G. 1992. The Val Biandino composite pluton: A late Hercynian intrusion into the South-Alpine metamorphic basement of the Alps (Italy). *Neues Jahrbuch für Mineralogie–Monatshefte*, 12, 545–554.

Sciunnach, D. 2001. Early Permian palaeofaults at the western boundary of the Collio Basin (Valsassina, Lombardy). *Natura Bresciana. Annuario del Museo Civico di Scienze Naturali, Brescia, Monografia*, 25, 37–43.