

Reply to comment by W. Kurz on "Tectonic map and overall architecture of the Alpine orogen"

Autor(en): **Schmid, Stefan M. / Fügenschuh, Bernhard / Kissling, Eduard**

Objektyp: **Article**

Zeitschrift: **Eclogae Geologicae Helvetiae**

Band (Jahr): **98 (2005)**

Heft 1

PDF erstellt am: **13.09.2024**

Persistenter Link: <https://doi.org/10.5169/seals-169162>

Nutzungsbedingungen

Die ETH-Bibliothek ist Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Inhalten der Zeitschriften. Die Rechte liegen in der Regel bei den Herausgebern.

Die auf der Plattform e-periodica veröffentlichten Dokumente stehen für nicht-kommerzielle Zwecke in Lehre und Forschung sowie für die private Nutzung frei zur Verfügung. Einzelne Dateien oder Ausdrucke aus diesem Angebot können zusammen mit diesen Nutzungsbedingungen und den korrekten Herkunftsbezeichnungen weitergegeben werden.

Das Veröffentlichen von Bildern in Print- und Online-Publikationen ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Die systematische Speicherung von Teilen des elektronischen Angebots auf anderen Servern bedarf ebenfalls des schriftlichen Einverständnisses der Rechteinhaber.

Haftungsausschluss

Alle Angaben erfolgen ohne Gewähr für Vollständigkeit oder Richtigkeit. Es wird keine Haftung übernommen für Schäden durch die Verwendung von Informationen aus diesem Online-Angebot oder durch das Fehlen von Informationen. Dies gilt auch für Inhalte Dritter, die über dieses Angebot zugänglich sind.

Reply to Comment by W. Kurz on “Tectonic map and overall architecture of the Alpine orogen”

STEFAN M. SCHMID¹, BERNHARD FÜGENSCHUH¹, EDUARD KISSLING² & RALF SCHUSTER³

We very much welcome the comment by Kurz (2005), which raises some important questions and allows us to further clarify some concepts behind our correlations between Western and Eastern Alps (Schmid et al. 2004). As a matter of fact, the principal question raised by Kurz (2005), namely the possible continuation of the Northpenninic (=Valais) ophiolites and Bündnerschiefer, originally defined in the Western Alps (Trümpy 1955, 1960), towards the east and into the area of the Tauern window (see Fig. 1 and plate 1 in Schmid et al. 2004) does not concern “details” (Kurz 2005), but represents a first order problem in any attempt to propose possible correlations of tectonic units and paleogeographical domains along the Alpine chain between Nice and Vienna.

As correctly stated by Kurz (2005), the Glockner nappe (referred to as “Upper Schieferhülle Unit” by Schmid et al. 2004), comprises remnants of an oceanic basement in the sense of a partly incomplete ophiolitic sequence, of course besides the volumetrically dominating calcschists referred to as “Bündnerschiefer” or “schistes lustrés” in the Western Alps. Indeed calcschists and ophiolitic remnants are not diagnostic for the Lower Penninic nappes derived from the Valaisan paleogeographical domain, and it is true that they also occur in Upper Penninic ophiolitic units of the Western Alps, derived from the Piedmont-Liguria ocean (such as in the Zermatt-Saas ophiolites of Western Switzerland and the Avers Bündnerschiefer of Eastern Switzerland). However, we do not understand why the fact that the Matri zone at the southern rim of the Tauern window is occasionally missing, the Glockner nappe often being in direct contact with the Austroalpine lid, “would favour a Southpenninic (= Piedmont-Liguria) origin of the Glockner nappe” (Kurz 2005). The Matri zone, which of course also contains calcschists (besides metapelites), is actually defined by the presence of tectonic slivers (or olistoliths

according to the interpretation of Frisch et al. 1987) of Austroalpine derivation (Kurz et al. 1998). This clearly makes the Matri zone an analogue of the Upper Penninic Arosa zone of Eastern Switzerland (Manatschal et al. 2003), also characterized by material derived from the Austroalpine domain (as parts of a tectonic *mélange* according to Lüdin 1987).

In Eastern Switzerland, as well as in the Tauern Window, these Upper Penninic units are considered as an integral part of the Cretaceous-age top-WNW nappe edifice by all workers. However, we differ from many Alpine geologists in that we follow Froitzheim et al. (1994, 1996) and consider top-WNW thrusting during Cretaceous orogeny as being very distinct from top-N thrusting during Tertiary orogeny, the two orogenies being separated by a Late Cretaceous (syn-Gosau) extensional event. It is Tertiary orogeny that led to the nappe stacking of the Lower Penninic (e.g. Glockner nappe), and the Subpenninic units (e.g. the “Zentralgneise” nappes, see Kurz et al. 1998), which constitute the deeper and major part of the Tauern window. Hence, contrary to the “classical interpretation” of most Austrian geologists (e.g. Frisch et al. 1987, Kurz et al. 1998), that envisage collision between the Zentralgneise and the Austroalpine margin to have occurred during Cretaceous orogeny, we interpret the contact between Glockner nappe and Matri zone to mark a tectonic contact between two nappe edifices that formed during two distinct orogenies (Cretaceous vs. Tertiary). Thereby we are led by the strong analogies between the architecture of the Engadine window, which demonstrably was not closed before Tertiary times (Froitzheim et al. 1994), and the Tauern window. This strong analogy is additionally supported by the results of along-strike reflection seismic data (Pfiffner and Hitz 1997, their line E2) which demonstrate that the Lower Penninic Bündnerschiefer of the Engadine window are directly underlain by basement

¹ Geologisch-Paläontologisches Institut, Department of Geosciences, Bernoullistr. 32, CH-4056 Basel, Switzerland. E-mails: Stefan.Schmid@unibas.ch; Bernhard.Fuegenschuh@unibas.ch

² Institute of Geophysics, ETH Hoenggerberg, CH-8093 Zuerich, Switzerland. E-mail: kissling@tomo.ig.erdw.ethz.ch

³ Geologische Bundesanstalt, Rasumofskygasse 23, A-1031 Wien, Austria. E-mail: Ralf.Schuster@cc.geolba.ac.at

units attributed to the European margin (topped by the Subpenninic Adula nappe), i.e. units that perfectly correspond to the „Zentralgneise“ (topped by the Tertiary-age Tauern Eclogite Zone) in the area of the Tauern window. Moreover, the parallelisation between the Valais Bündnerschiefer of the Engadine window and the Glockner nappe of the Tauern window was recently confirmed on sedimentological grounds (Bertle 2004). Consequently, we cast doubts on the existence of a “Middle Penninic Zentralgneis block” (Frisch 1979, Kurz et al. 1998) in the area of the Tauern window, separated from proximal Europe by the Rhenodanubian flysch trough, regardless of the question as to whether this “block” represents the Briançonnais microcontinent (Tollmann 1965) or a part of the stable European continent (Kurz et al. 1998). Instead, we consider the Lower Penninic Rhenodanubian flysch to be rooted above and behind the „Zentralgneise“ of the Tauern window, in an even more internal position in respect to the Bündnerschiefer of the Glockner nappe (see Oberhauser 1995). It is clear that our alternative view demands by far more substantial N-S-shortening during Tertiary orogeny than commonly assumed by geologists working in the Eastern Alps, i.e. values that amount to some 500km (as calculated in Eastern Switzerland by Schmid et al. 1996) or even more.

We agree with Kurz (2005), and in fact we were rather explicit about this in our article (see Fig. 2c in Schmid et al. 2004), who states that “possibly the Briançonnais primarily ended between the Engadine and the Tauern Window, whereby the North- and Southpenninic basins merged eastward into a joint basin (Froitzheim et al. 1996)”. Of course the front of the Briançonnais could theoretically also be located south of the Tauern Window, as proposed by Kurz (2005), having completely disappeared by subduction (see also Froitzheim et al. 1996). Hence this postulate cannot be excluded, although it appears rather hypothetical since no evidence for high-pressure metamorphism is found in the very thin Briançonnais-derived sliver that outcrops in the Engadine window nearby (Tasna nappe, see Florineth and Froitzheim 1994).

Kurz (2005) reports that the paleogeography proposed by Trümpy (1988) shows that the Briançonnais ends east of the Engadine Window, as was proposed by us (Schmid et al. 2004). However, when Kurz (2005) writes that lateral displacement of the Briançonnais to the east, “re-occurring in the Pienidic Unit of the Western Carpathians” (he refers to parts of the Pieniny Klippen Belt, namely the so-called Czorstyn unit, see Birkenmajer 1986), he unfortunately misinterprets Trümpy (1988) who writes: „These platforms are not continuous; thus the Briançonnais belt disappears eastward in western Tyrol...” (Trümpy 1988, page 106).

Kurz (2005) correctly remarks that the paleogeographic separation into North- and Southpenninic becomes somewhat artificial in the Eastern Alps since the North- and Southpenninic basins, due to the disappearance of the Iberia-Briançonnais microcontinent, merged into one single Penninic basin east of the Engadine Window (e.g., Stampfli 1993, Froitzheim et al. 1996). We are fully aware of this problem and we do not

wish to repeat the four criteria outlined in our article (Schmid et al. 2004, p. 99), except for re-mentioning the most important criterion, namely that of the age of accretion of these oceanic units (Late Cretaceous vs. Tertiary). By using this criterion we were again guided by the concept that two distinct orogenies affected the eastern Alps. Hence, we attributed the Rhenodanubian flysch, accreted to the Alpine nappe stack in Eocene times, to the Valais ocean, although it contains slices of Piemont-Liguria origin (Ybbsitz Zone of Decker 1990). These slivers occur at the base of the Kahlenberg nappe, which has also been interpreted as an element from the southern margin of the joint oceanic basin by Faupl & Waggreich (1992). On the other hand the Laab and Main Flysch nappes consist of material derived from the European margin in the north (e.g. Trautwein et al. 2001).

Rather than discussing a South Penninic (Piemont-Liguria) origin of the Rhenodanubian flysch, as suggested by Kurz (2005), we would like to propose that Wäggitaler, Schlieren and Gurnigel flysch units of the Swiss Alps, in which sedimentation does not stop before Eocene times, could also belong to the Valais oceanic domain (following a suggestion by R. Trümpy, written communication), contrary to common belief amongst Swiss geologists since the publication of Caron et al. (1989). We regret that we did not have the courage to propose this alternative view in our tectonic map, which we now consider by far more logical. However, at the same time we are glad to give credit to the grand old man of Alpine geology for first having made this “heretic” suggestion.

REFERENCES

- BERTLE, R. 2004: The sedimentary record of North Penninic Schistes lustrés of the Lower Engadine Window and its correlation to the Tauern window (Eastern Alps). *Jb. Geol. B.-A.* 144, 165–171.
- BIRKENMAJER, K. 1986: Stages of structural evolution of the Pieniny Klippen Belt, Carpathians. *Studia Geologica Polonica*, 88, 7–31.
- CARON, CH., HOMEWOOD, P. & WILDI, W. 1989: The original Swiss flysch: a reappraisal of the type deposits in the Swiss Prealps. *Earth-Sci. Rev.* 26, 1–45.
- DECKER, K. 1990: Plate tectonics and pelagic facies: Late Jurassic to Early Cretaceous deep-sea sediments of the Ybbsitz ophiolite unit (Eastern Alps, Austria). *Sediment. Geol.* 67, 85–99.
- FAUPL, P. & WAGREICH, M. 1992: Cretaceous flysch and pelagic sequences of the Eastern Alps: correlations, heavy minerals, and palaeogeographic implications. *Cretaceous Res.* 13, 387–403.
- FLORINETH, D. & FROITZHEIM, N. 1994: Transition from continental to oceanic basement in the Tasna nappe (Engadine window, Graubünden, Switzerland): evidence for Early Cretaceous opening of the Valais ocean. *Schweiz. mineral. petrogr. Mitt.* 74, 437–448.
- FRISCH, W., GOMMERINGER, K., KELM, U., & POPP, F. 1987: The Upper Bündner Schiefer of the Tauern Window – A Key to Understanding Eoalpine Orogenic Processes in the Eastern Alps. *Geodynamics of the Eastern Alps*, 55–69.
- FROITZHEIM, N., SCHMID, S.M. & CONTI, P. 1994: Repeated change from crustal shortening to orogen-parallel extension in the Austroalpine units of Graubünden. *Eclogae geol. Helv.* 87, 559–612.
- FROITZHEIM, N., SCHMID, S. M., & FREY, M. 1996: Mesozoic paleogeography and the timing of eclogite facies metamorphism in the Alps: A working hypothesis. *Eclogae geol. Helv.* 89, 81–110.

- PIFFNER, O.A. & HITZ, L. 1997: Geologic interpretation of the seismic profiles of the Eastern Traverse (lines E1-E3, E7-E9): eastern Swiss Alps. In: Deep Structure of the Swiss Alps: Results from NRP 20 (Ed. by Piffner A.O. et al.). Birkhäuser Verlag, Basel, 73–100.
- KURZ, W. 2005: Comment on „Tectonic map and overall architecture of the Alpine orogen“ by S.M. SCHMID, B. FÜGENSCHUH, E. KISSLING & R. SCHUSTER *Eclogae geol. Helv.* 97, 93–117. *Eclogae geol. Helv.*, this volume.
- KURZ, W., NEUBAUER, F., GENSER, J. & DACHS, E. 1998: Alpine geodynamic evolution of passive and active continental margin sequences in the Tauern Window (eastern Alps, Austria, Italy): a review. *Geol. Rdsch.* 87, 225–242.
- LÜDIN, P. 1987: Flysch- und Melange-Bildungen in der südpenninisch-unterostalpinen Arosa Zone. Unpublished PhD Thesis, University of Basel.
- MANATSCHAL, G., MÜNTENER, O., DESMURS, L. & BERNOULLI, D. 2003: An ancient ocean-continent transition in the Alps: the Totalp, Err-Platta and Malenco units in the eastern Central Alps (Graubünden and northern Italy). Excursion of the Swiss Geological Society, September 20 to 24, 2002. *Eclogae geol. Helv.*, 96, 131–146.
- OBERHAUSER, R. 1995: Zur Kenntnis der Tektonik und der Paläogeographie des Ostalpenraumes zur Kreide-, Paleozän- und Eocän-Zeit. *Jb. Geol. B.-A.* 138, 369–432.
- SCHMID, S.M., PFIFFNER, O.A., FROITZHEIM, N., SCHÖNBORN, G. & KISSLING, E. 1996: Geophysical-geological transect and tectonic evolution of the Swiss-Italian Alps. *Tectonics* 15, 1036–1064.
- SCHMID, S.M., FÜGENSCHUH, B., KISSLING, E. & SCHUSTER, R. 2004: Tectonic map and overall architecture of the Alpine orogen. *Eclogae geol. Helv.* 97, 93–117.
- STAMPFLI, G. 1993: Le Briançonnais: Terrain exotique dans les Alpes? *Eclogae geol. Helv.* 86, 1–45.
- TOLLMANN, A. 1965: Die Fortsetzung des Briançonnais in den Ostalpen. *Mitt. Geol. Ges. Wien*, 57, 469–478.
- TRAUTWEIN, B., DUNKL, I., KUHLEMANN, J., & FRISCH, W. 2001: Geodynamic evolution of the Rhenodanubian Flysch Zone – evidence from apatite and zircon fission-track geochronology and morphology studies on zircon. In: Paleogene of the Eastern Alps (Ed. by PILLER W.E. & RASSER M.W.). *Österr. Akad. Wissensch. / Schriftenreihe der Erdwissenschaftlichen Kommissionen*, 14, 111–128
- TRÜMPY, R. 1955: Remarques sur la corrélation des unités penniques externes entre la Savoie et le Valais et sur l'origine des nappes préalpines. *Bull. Soc. géol. de France*, 6ème série tome V, 217–231.
- TRÜMPY, R. 1960: Paleotectonic evolution of the Central and Western Alps. *Bull. Geol. Soc. America*, 71, 843–908.
- TRÜMPY, R. 1988: A possible Jurassic-Cretaceous transform system in the Alps and the Carpathians. *Geol. Soc. America Spec. Paper* 218, 93–110.

Manuscript received February 12, 2005

Revision accepted April 15, 2005

