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Symposium Metamorphism and Deformation

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Introduction

by *Martin Frey*[1], *Stefan M. Schmid*[2] and *Arnold Stahel*[3]

A one-day symposium entitled "Metamorphism and Deformation" was organized by the Swiss Geological Society and the Swiss Society of Mineralogy and Petrology. The meeting was held in Basel on October 2, 1992 and brought together researchers and students active in two overlapping fields of earth sciences. A better understanding of interactions between metamorphism and deformation was the most important goal of this symposium. For a long time, metamorphic petrology and structural geology developed with little interaction. However, most metamorphic rocks possess a fabric and followed a pressure-temperature-time-deformation (P-T-t-d) path. The conveners therefore believe that metamorphism and deformation should be treated together, particularly in the case of field studies. This certainly leads to a more complete understanding of tectonometamorphic processes active during orogeny. The following articles and abstracts illustrate this for a large variety of geological settings.

This special issue of Swiss Bulletin of Mineralogy and Petrology publishes the results of field and microstructural observations combined with the application of established thermobarometry and more recently developed petrological methods. The articles concentrate mainly on the pre-Alpine and Alpine tectonometamorphic evolution of the Alps. As can be seen from the abstracts at the end of this volume the symposium was not restricted to the Alpine chain. The theoretical and experimental studies also presented at the symposium indicate directions of future work.

The articles are summarized shortly below. They are ordered in a possible sequence that emphasizes thematic affinities.

THÖNI and JAGOUTZ use detailed isotopic constraints to unravel the long-lasting history of rifting and collision associated with Early Alpine high-P metamorphism in the Austroalpine nappes. Rifting apparently started surprisingly early (Permian). Eclogite metamorphism is bracketed between 150 and 90 Ma and affected a large area within the southern Austroalpine units of the Eastern Alps. This metamorphism was followed by exhumation which ended at about 70 Ma. Rapid exhumation is considered to be one main reason for the preservation of unaltered eclogites of both Koralpe and Saualpe.

TROMMSDORFF et al. describe field relationships between mantle and crust-derived lithologies of the Penninic/Austroalpine border region from Val Malenco, Italy. Combined observations on magmatism, metamorphism and deformation suggest a complex sequence of rock-forming and tectonic events related to Mesozoic rifting followed by Alpine orogeny. They propose that the

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Malenco serpentinite represents subcontinental mantle, altered during exhumation and denudation on a former ocean floor.

BALLÈVRE and MERLE deduce from geobarometric data a considerable pressure gap across the Combin Fault in the northern part of the Western Alps. The metamorphic and structural analysis of this fault leads to the idea that the Combin Fault was active during a period of crustal extension, and that it may be responsible for most of the exhumation of some ultra-high-pressure rocks in the Western Alps. They argue that displacements achieved during extensional faulting may outweigh those related to later overprint by subsequent thrusting.

SELVERSTONE summarizes some of her and her co-workers earlier studies from the western Tauern Window in the Eastern Alps. Deformational and metamorphic processes related to N–S convergence followed by E–W-extension are reviewed for the Lower and Upper Schieferhülle, the Brenner Line normal fault zone, and the Greiner shear zone. She argues that localized deformation at depths of 5–40 km affected bulk chemistry, fluid migration properties, and development of P-T-sensitive assemblages, all of which contribute to our ability to read the tectonometamorphic rock record.

KAMBER redefines the position of the Helvetic-Penninic tectonic boundary for the Nufenenpass area along the southern margin of the Gotthard "massif". The location of this boundary is based on lithological evidence, microstructural observations and geothermobarometric data. The Penninic units show an abrupt increase of metamorphic conditions ($\Delta T \approx 40$ °C, $\Delta P \approx 1$ kbar), documenting a relative uplift of the Penninic units by about 3.5–4 km. The strong N to S increase of metamorphic grade in the Nufenenpass area is explained by the juxtaposition of higher and lower grade rocks.

SPALLA combines microstructural and geothermobarometric data to derive part of a retrograde P-T-t-d path for some metapelites of the Austroalpine Texel Gruppe, Eastern Alps. She points to the importance of microstructural control for a successful interpretation of thermobarometric estimates. This control allows for a tighter control on P-T intervals derived with petrological methods.

MEYRE and PUSCHNIG document the tectonometamorphic evolution at Trescolmen in the lower Penninic basement Adula nappe of the Central Alps. Four stages of Alpine deformation (D1–D4) were recognized. The clockwise P-T-t-d path is characterized by metamorphic conditions of the eclogite facies (during D1), eclogite to middle amphibolite facies (during D2), lower amphibolite facies (during D3), and greenschist facies (during D4).

BAUDIN and MARQUER analyzed the phengitic substitution in K-white micas from the Penninic Tambo nappe of the Central Alps. Using the geobarometer of Massone and Schreyer, pressure estimates were obtained for carefully selected microstructural sites correlated with the two main ductile deformation events during Tertiary time. The crustal thickening event D1 related to nappe formation yields 10–13 kbar. E–W extension during D2 caused decompression to 5–10 kbar.

SCHULZ studied the P-T-t-d path of Variscan metapelites in the Austroalpine basement to the south of the Tauern Window. Based on microstructural criteria, P and T for successive stages of syndeformational garnet growth were derived. Different shapes of P-T paths were found for different tectonic units, and interpreted by a progressive stacking process during an early-Variscan continental collision.

The contribution by GUILLOT et al. – as supplement added to this volume – is not directly related to the topic of the Symposium but indicates the importance of geochemical aspects. This is done by comparing the Mt. Pourry volcanic basement which shows no Variscan metamorphism with similar sequences where this imprint was much stronger.

The complete special issue can be obtained from the editor (A. Stahel, Institut für Mineralogie und Petrographie ETH-Zentrum, CH-8092 Zürich or Stäubli AG, Postfach 566, CH-8045 Zürich, Switzerland) at a price of Sfr. 40.– (+ shipping) per copy. Please order reprints of individual articles directly from the authors.