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Isotope geothermometry within the southern Tauern Window

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Aim of the study

Remnants of South-Penninic oceanic sediments are now exposed in the Tauern Window, beneath the Austroalpine Complexes. During Cretaceous times this oceanic basin was flanked by the northern Middle Pennin continental block and the southern Austroalpine continental block. The Cretaceous sedimentary facies distribution includes (Kurz et al. 1998): 1) Oceanic basin sediments with carbonatic – clastic deep water sediments that grade upwards into flysch-type deposits ("Glockner Facies"). The sediments were deposited on oceanic crust. 2) Relatively pure carbonates have been deposited on northern ("Venediger Facies") and southern (Austroalpine Complex, "Mattrei Facies") continental margins. 3) An intermediate position with carbonatic and clastic sequences developed along the northern continental slope and along rift-related escarpments (Rote Wand – Modereck Facies). During closure of the oceanic domain, sediments and basement rocks have been incorporated into a nappe pile with the Venediger Nappe in footwall position, the Rote Wand – Modereck Nappe in an intermediate position and the Glockner Nappe in a hangingwall position. Closure of oceanic domains and subsequent underthrusting of Penninic continental units (Venediger Complex) beneath the Austroalpine caused crustal thickening, burial and heating of Penninic units. Final exhumation and cooling of Penninic Tauern Window units in Paleogene times left a distinct zonation of paleothermal isogrades with high tempered units in central Tauern Window portions and low tempered units along the Tauern window margin. Simultaneously with Tauern Window exhumation lateral extrusion tectonics (pronounced West – East stretch) modified the primary configuration of units and may have eventually disturbed the paleo-isograde pattern.

We performed an isotope study along a profile from the southern Tauern Window margin (Glockner Nappe) to central portions (Venediger Nappe). Aim of the study was to (1) obtain information on primary sedimentary environment, (2) to reconstruct the paleo-temperatures along the profil, and, (3) to check possible disturbances created by tectonics. This work expands on previous isotope studies by e.g. Hoernes and Friedrichsen (1978).

Data and interpretation

We sampled very similar lithologies along a profile ("Kalkglimmerschiefer") across Glockner Decke (GD), Rote Wand – Modereck Decke (RWMD) and Venediger Decke (VD) that consist essentially of three mineral types, calcite, quartz and muscovite. Calcite is major phase with 60%-90% $_{\text{(volume)}}$ in all samples, other phases are below 2% $_{\text{(volume)}}$. Calcite was analysed for $\delta^{13}C$ and $\delta^{18}O$ using the automated system Kiel II, O_2 ($\delta^{18}O$) in silicate phases was analyzed using a Laser Fluorination line with BrF_5 as reagent gas.

The $\delta^{13}C$ and $\delta^{18}O$ values of all minerals are distinctly different within the three nappes as exemplarily shown for $\delta^{18}O$ in Fig 1. This correlated with the reported facies distribution. Rocks from the GD are interpreted to represent clastic carbonatic sediments of anoxic environment. Degassing of CO_2 may have caused the negative $\delta^{13}C$ values. By contrast, the heavy $\delta^{13}C$ and $\delta^{18}O$ values from the VD characterize sediment from a shallow marine swell position.

The three coexisting mineral phases do give concordant temperatures for samples from the VD but highly discordant temperatures for samples from the GD. Here two species of calcite occur with an early phase within the matrix and younger calcite grown in microveins an tension gashes. Cathodoluminescenz studies clearly indicate disequilibria between calcite and other minerals phases. Most plausible temperatures are obtained from calcite / muscovite pairs (Figs. 1, 2) and show increase of temperatures from ca. 380° in the south (GD) to c. 530° in the north (VD). This fits observed temperature estimations based on microstructures. Microstructures and stable isotope data suggest that the Glockner Nappe suffered a late, shallow level tectonic event during final exhumation of the Tauern Window and lateral extrusion tectonics. This event is not recorded in central Tauern Window portions.

With the "fast grain boundary" program package of Eiler et al. (1994) we started to model cooling rates from central an marginal Tauern Window portions. First results suggest rapid cooling and exhumation in the VD (Tauern Window interior) and slow cooling in the GD.

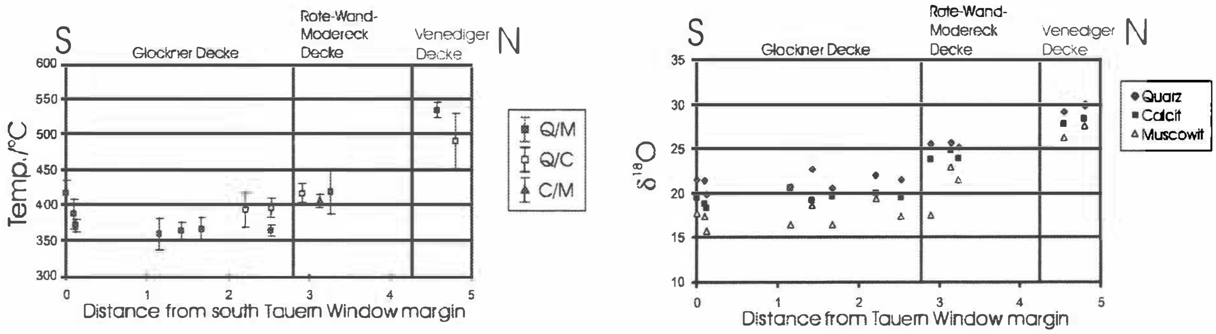

Figure 1: Temperature variation (lefrt) and raw data (right) from the southern Tauern Window

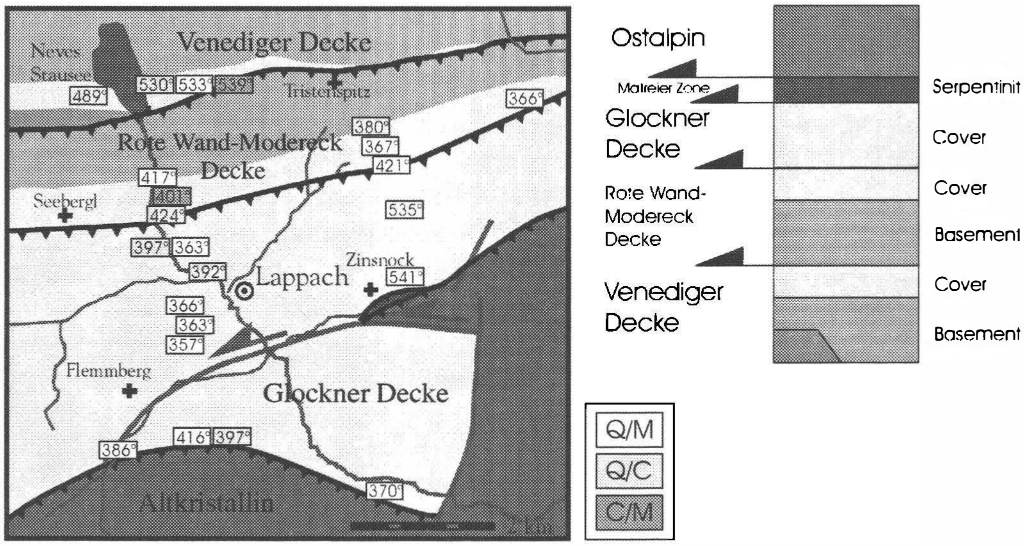

Figure 2: Temperature variation within three nappes from the southern Tauern Window

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Automatic Determination of Content and ^{15}N abundance of Total Dissolved Nitrogen in Watery Samples and Soil Extracts by TOC Analyser-Mass Spectrometer Coupling

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The standard method for determining the ^{15}N abundance of total dissolved nitrogen (TDN: org. N + NH_4^+-N + NO_3^--N) in aqueous samples (e.g. soil leachate, sewage, urine) is currently Kjeldahl digestion followed by steam distillation or diffusion to isolate the ammonium, and then ^{15}N measurement using IRMS (Bremner & Mulvaney, 1982, Brooks et al., 1989). However, this technique is both time-consuming and laborious. Using elemental analyser-IRMS coupling is impossible owing to the required sample volumes of $\geq$ 0.5 ml. A solution to this problem emerged with the availability of TOC analysers to determine the total dissolved carbon and nitrogen in aqueous samples. The HighTOC analyser (Elementar Hanau, Germany), which catalytically oxidizes the sample's total nitrogen with a high, constant yield to form nitrogen monoxide (NO), appeared particularly suitable. As ^{15}N determination of NO using mass spectrometry had already proved successful (Russow & Stevens, 1996, Sich & Russow, 1999) online coupling with a suitable MS via the combustion product NO ought to enable the rapid, automatic ^{15}N determination of the total dissolved nitrogen in a sample with sufficient sensitivity and accuracy. The Quadrupol-MS ESD 100 (InProcess Instruments Bremen, Germany) proved to be a suitable mass spectrometer. It is known that oxygen, necessary for a sufficient combustion, has a big impact on the detection of the relevant masses 30 and 31 by the mass spectrometer. This causes changes in the background of the MS record which lead to unacceptable incorrect ^{15}N determinations. This problem could be solved by a indirect coupling of the TOC analyser to the QMS via a cryotrap immersing into liquid nitrogen working after the "trap and flash" principle (Sich & Russow, 1998). The coupling of the instruments described was found in numerous measurements of standard and real samples to provide a workable method. The detection limit is about 2 μg of nitrogen, corresponding to an N concentration of 0.07 mg/l in a maximum dosage volume of 3 ml. Depending on the N concentration, ^{15}N abundances starting from 0.5 at.% can be measured with the required precision of better than 3% (simple standard deviation). For example, measuring the abundance of 0.5 at.% requires about 50 μg N, whereas as of 1 at.% only about 5 μg N is needed per analysis.

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