Study of the thermal history of the Miocene Jarando basin (Southern Serbia)

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The Jarando basin is located in SSW part of Serbia and belongs to the internal Dinarides. It was formed during the Miocene extension affecting the whole Alpine-Carpathian-Dinaride system (SCHMID et al., 2008). In the study area Miocene extension led to the formation of a Studenica core-complex (SCHEFER et al., 2011) with the Jarando basin located in the hanging wall of the detachment fault.

The Jarando basin is characterized by the presence of bituminous coals, whereas in the other intramontane basins in Serbia coalification did not exceed the subbituminous stage within the same stratigraphic level. Furthermore, the basin hosts boron mineralization (borates and howlite) and hydrothermal-sedimentary magnesite, which indicate elevated temperatures.

Possible heat sources in the study area are magmatic activity, core-complex formation and burial of sediments. The intense Tertiary magmatic activity is represented by Oligocene I-type Kopaonik granodiorite, Miocene S-type Polumir granitoid, volcanics (SCHEFER et al., 2011) and subsequent hydrothermal fluid flow. The juxtaposition of warmer footwall units against cooler hanging wall units via rock uplift and exhumation of the Studenica core-complex could produce high heat flow in the Jarando basin.

This paper is aimed at providing new information about the thermal history of the Jarando basin. The vitrinite reflectance was measured for 11 core samples of shales from one borehole and 5 samples of coal from an underground mine. Fifteen core samples from three boreholes and 10 samples from the surrounding outcrops were processed for apatite and zircon fission-track analysis.

VR data reveal a strong post-depositional overprint. Values increase with the depth from 0.66-0.79% to 0.83-0.90%. Thus organic matter reached the bituminous stage and experienced temperatures of around 110-120˚C (BARKER & PAWLEWICZ, 1986). All zircon grains from samples are older than the age of sedimentation. FT single grain ages for apatite scatter between 45 Ma to 10 Ma with a general trend towards younger ages with depth. The mean track length varies from 9.90±2.45μm to 12.32 ±2.23μm. Both the spread in single grain ages and the bimodal track lengths distribution clearly point to partial annealing of the detrital apatites. The temperatures given from the VR data and thermal modeling indicate short-lived thermal event around 15-12 Ma. The VR values and apatite FT modeling suggest two paleo-thermal events, heating and subsequent cooling. We correlate the thermal event with the extension and core-complex formation followed by the syn-extensional intrusion of the Polumir granite. Later cooling from 10 Ma onwards is related to basin inversion and erosion.

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Quartz vein formation during decompression and recrystallization in the Venediger Nappe Complex and Eclogite Zone of the southern Tauern Window (Eastern Alps): Fluid Inclusions linked with structures

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The Variscian Basement (Venediger Nappe Complex) and the Eclogite Zone are parts of the Subpenninic Units of the Tauern Window in the Eastern Alps. The investigated area, located in the southern Tauern Window along the Frosnitztal (Eastern Tyrol), shows asymmetric domino boudin structures with quartz-filled vein necks within the Venediger Nappe Complex. The amphibolite host rocks are surrounded by a layered penetrative foliation consisting of leucocratic melts (leucosomes) which can be linked with the Permian-Carboniferous intrusion of the Zentralgneis. Quartz samples are taken from the leucosomes and from the boudin neck structures.

In the Eclogite Zone concordant quartz layers occur beside carbonate-bearing micaschists and a penetrative foliation consisting of omphacite + garnet + epidote/zoesite + glaucophane. Three generations of fluid inclusions have been distinguished. On the basis of the textural occurrence and rheological characteristics, the chemistry of the metamorphic fluid during recrystallization of the leucosome layers and quartz-filled vein neck formation is reconstructed. It can be shown that during recrystallization and decompression the grade of salinity increases from about 6 to 15 mass% accompanied with a small change in the aqueous system H_2O-NaCl-$MgCl_2$±$CaCl_2$. This change occurred at estimated maximum P conditions around 850 MPa and temperatures of 500-550°C (fluid inclusion generation 1). Subsequent healing of micro-cracks postdates recrystallization in the range between 600 and 350 MPa (fluid inclusion generation 2). Restricted to the boudin necks a late fluid generation of primary character consisting of CO_2-H_2O-NaCl chemistry indicates entrapment conditions between 250-300 MPa which is linked with a late stage quartz vein precipitation in the boudin necks (fluid inclusion generation 3). These late veins are not recrystallized and contain conjugate microcracks that are different to earlier cracks which healed in recrystallized quartz aggregates (intragranular versus transgranular plane characteristics). In this late quartz vein generation fluid inclusion decrepitation features indicate isobaric cooling at the latest stage of the PT-evolution of the Venediger Nappe Complex.

Fluid Inclusions from a concordant folded quartz layer in the Eclogite Zone are compared to the fluids in the Venediger Nappe Complex but significantly different in their chemistry and densities. They are dominated by the N_2-CH_4-H_2O system and texturally arranged along intragranular planes within totally recrystallized quartz grains. The fluid chemistry of ca. 90 mol% N_2 can be related to the breakdown of K-bearing minerals like feldspar and mica during retrogression of the eclogitic host rock. Additionally a rare occurrence of pure aqueous inclusions is observed along cracks. Calculated low densities are indicative for reequilibration and leakage due to decompression and recrystallization.