subfacies, retrogressive mineral assemblages are indicative of greenschist facies, particularly of quartz – albite – biotite – muscovite – chlorite, and locally, quartz – albite – epidote – almandine subfacies conditions. To understand the complex PT path of this group, we used the petrographic microscopy combined with microprobe analyses of some mineral pairs and geothermobarometrical calculations. The data presented in this paper set new petrological constraints for the interpretation of the tectono-metamorphic history of the Rebra Group. The garnets of the Rebra Group rocks display a large dimensional variation (submillimetric to centimetric sizes) and they have a prevalently almandinic composition. The garnets from Rebra Group could grow in three main phases. The first generation garnets grow prekinematical (68-77% almandine, 10-20% grossular) in relation to the penetrative S2, enclosing relic isoclinal fold-marking trails of quartz and ilmenite grains, followed by syn-kinematic second generation garnets(55-75% almandine, 15-25% grossular), which overgrew, partly simultaneously with Fe-Mg chloritoid, epidote core and tourmaline grains. More or less before the garnet overgrowth, could been active a boron and sodium rich solution transport with dravit- schorl series tourmaline grains genesis. The garnet 3 blasthesis was postkinematic in relation to S2 and was observed on corroded rims of earlier ones.The centrimetric sized garnet porphyroblast from micaschists may preserve some remnant minerals from the prograde phase and peak conditions, which are missing in the rock matrix. Such minerals are: chloritoid, REE- rich epidote, Cr-spinel.

Using garnet – biotite geothermometry for Rebra Group rocks temperatures of 425 – 550 °C were calculated. Calcite – dolomite solvus geothermometry indicated 350–430 °C (retrogressive conditions), while amphibole – garnet geothermometry and phengite geobarometry for the Rebra Group amphibolite yielded temperatures between 550 and 630°C (peak conditions). Using Ca-amphibole – plagioclase geothermometry for the same samples 550 °C and 7 ± 1 kbar were calculated. The garnet porphyroblast of metapelites are the most indicative for PT path evolution and their matrix minerals (fengit, ilmenite, albitised oligoclase, zoned epidote group minerals with La, Cr, Y, chlorite, and apatite), because may contains beside the quartz inclusion trails, some other minerals such as: ilmenite, ilmenite-magnetite intergrowth, Cr spinel, apatite, tourmaline (dravit- schorl series), fengite, epidote group minerals and chloritoid (the first record of it in this metamorphic group garnets). Geothermobarometric calculations using microprobe data on centimetric sized garnets and its inclusions from Valea Blazna Gallery micaschists samples evidenced: by garnet- ilmenite geothermometry 678 ± 30 ºC and phengite geobarometry 7 kbar for the metamorphic peak conditions; the garnet-tourmaline, tourmaline-muscovite thermometry evidenced a prograde phase temperature of 450 ºC and a minimum pressure of 4Kb (phengite geobarometry). The garnet rim-ilmenite (matrix) pair outlined 498 ± 30 ºC, and plagioclase- muscovite pair data 422 ºC and 3.5 kbar pressure for retrogression conditions.

High-precision P-T estimates for retrogressed kyanite eclogites from Thermes, central Rhodope (Greece)

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The Rhodope massif in northern Greece and southern Bulgaria constitutes the hinterland of the Hellenide orogen. It exposes low- and high-grade metamorphic rocks and their sedimentary cover. Kyanite eclogites from Thermes-Rhodope (northern Greece) belonging to the structurally upper unit were studied in order to constrain their metamorphic conditions. The kyanite eclogites are boudins enclosed in quartzofelspathic gneisses. They experienced a polyphase metamorphic history involving equilibration at granulite-, amphibolite- and greenschist-facies conditions successively. Textural relations reveal the successive equilibrium mineral assemblages and provide constraints that very local, domainal equilibria were attained during metamorphic evolution. Omphacite formed symplectites of diopsidic pyroxene and plagioclase during decompression while garnet formed coronas of two amphiboles (ortho- and clino-), plagioclase and magnetite. The orthoamphibole is sodic gedrite with the most sodic composition found in the literature. Symplectites of plagioclase, spinel and corundum formed at the expense of kyanite suggesting some metasomatic process. During metasomatism the mineral chemistry and the local composition of the equilibration volume were modified by diffusion processes, thus nullifying any assumption that the system was closed. Conventional geothermobarometric methods and thermodynamic modelling were combined to decipher the evolution in the rock mineral assemblages as a response to P-T conditions. Modelling revealed that the formation of sapphirine, corundum, spinel and plagioclase symplectites after kyanite is only possible during decompression at pressures less than 0.8GPa.

Joint inversion of compressional and shear wave traveltime data, using velocities-ratio constraint with spatially variable weighting

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In order to improve the resolution of traveltime seismic tomography surveys, P and S-wave traveltimes can be used complementary under a joint inversion scheme. Usually both P and S arrivals can be obtained with minimum additional effort; therefore joint inversion of these datasets offers an inexpensive and efficient way to improve their interpretation. A joint inversion algorithm of P and S traveltimes can maximize useful information from existing datasets and enhance the effectiveness of seismic refraction tomography surveys. In this work we present a joint inversion algorithm that inverts the two different datasets subject to a velocity ratio linking constraint. This constraint could be constant for all model parameters or could vary spatially, depending on the available information. The compressional to shear waves velocity ratio value can be roughly estimated from existing a-priori information, based on well logging or lab measurements or even can be estimated from geological information. A critical issue regarding joint inversion schemes is the significance of the constraint equations in the overall inversion procedure. If this constraint is too lose then the cross-correlation between the parameters of different type is negligible and the two models vary independently, degrading the joint inversion scheme in two separate inversions. On the contrary if too heavy weighting is applied, the solution is strongly biased towards the a-priori assumption, neglecting the actual data information. The participation of linking equation is controlled by a Lagrangian multiplier, which is usually defined empirically (i.e. extracted from a trial and error procedure) and is adopted as uniform for the whole model area. We introduce a spatially variable Lagrangian multiplier vector instead of a scalar one that scales differently the ratio constraint for each pair of parameters. The weighting is based on the parameter resolution matrices of the two models and spread function analysis. For highly resolvable parameters, a small value of the Lagrangian multiplier is assigned and the parameters are allowed to vary almost independently. For poorly resolved parameters, the Lagrangian multiplier that is assigned is large and due to the lack of information the specific parameters are forced to follow the ratio constraint. This method allows areas of the models with high information density values to vary based on this information rather than the ratio constraint equations, preserving the information content and the contrast that separate inversions would provide. At the same time the areas of the models which are lacking of resolving power and introduce instability under independent inversions, are constrained under the joint inversion scheme. Additional regularization is used and spatially variable smoothness is also applied to the models parameters. Testing with synthetic and real data suggest that the presented joint inversion algorithm can lead to improved results, stabilize the inversion process and reduce the non-uniqueness of the problem.