Record of two Alpine high-P metamorphic events in the Titaros ophiolite complex of the Pelagonian zone (Greece)

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We present new petrological data of the Titaros ophiolite complex and discuss their significance for the Alpine geodynamic evolution in the Pelagonian realm. There are two Alpine high-P metamorphic stages. The first stage, at pressures between 0.8-1.4 GPa and minimum temperatures 570-610 ºC occurred in late Jurassic/early Cretaceous and is associated with the obduction of the ophiolite complexes onto the Pelagonian crust. At this stage the Titaros ophiolite was subducted together with crustal rocks of the Pelagonian zone as a result of tectonic erosion of the ophiolite margin. The second stage occurred in the Eocene at much lower temperatures (about 400 ºC and minimum pressure ~0.7 GPa). It is interpreted to reflect the final closure of the Vardar-Axios ocean and collision/underthrusting of the Apulia microcontinent under Europe.

Alpine polyphase metamorphism in metapelites from Sidironero Complex (Rhodope Domain, NE Greece)

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Metamorphic mineral ages from garnet-kyanite gneisses in the area north of Xanthi documented a Jurassic and an Eocene metamorphic event in the Sidironero complex of the Rhodope domain. The two metamorphic events are well imprinted in the mineral assemblages, mineral compositions and textural relationships of metapelites within the Nestos Shear Zone in the Sidironero complex. The Jurassic event at HP-UHP metamorphic conditions is characterized by the mineral assemblage garnet-kyanite-Ti-rich phengite at the peak pressure. The Eocene metamorphic event at moderate HP conditions and minimum pressure > 0.9 GPa is characterized by the mineral assemblages St-Grt-Ms-Ky-Bt with garnet growth at the expense of kyanite or staurolite, and Grt-St-Ky-Bt with peak P-T conditions within the St+Bt+Ky stability field.

Numerical analysis of shallow landsliding – an option to substantiate mass movement hazard assessment (case study in Beskid Niski, Polish Flysch Carpathians)

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Mass movements have adverse effect on environmental assets but they are also devastating to elements at risk associated with landuse and man-made structures or even lead to casualties. For the purpose of loss reduction current Polish legislative regulations require local and regional authorities to establish registers and maps denoting areas prone to mass

movement hazard and to take them into account in guidelines for landuse planning and management. Although Poland is still lacking an officially recognized methodology, the first attempts towards landslide hazard and risk assessment at medium scale survey (1:10 000) has been undertaken in a test study area near Szymbark (Bystrzanka and Biczyska catchments), Beskid Niski Mts., Outer Carpathians.

The test area, historically known as prone to slope failures, is located in the contact zone of Magura and Silesian nappe structures with typical flysch formations (alternated sandstones, conglomerates, claystones, mudstones and shales) of Cretaceous to Oligocene age. The flysch is often mantled with weathered material forming slope covers (clays, loams, silty sands and debris). Lithologic setting combined with tectonics contributes to a wide array of gravitational mass movements. Due to climatic setting, rain- and snowmelt induced failures are typical. Owing to coupled effects of environmental and triggering factors, slow deep-seated slides (rotational, translational and compound slides) as well as reasonably fast shallow slips (or even earth flows) are observed.

Statistical relationships between past landslide occurrences and conditioning variables were used to make predictions for areas currently free of landslides and for their likely distribution. Analysis involved usage of GIS techniques in Bystrzanka-Biczyska test area, landslide susceptibility assessment was performed using empirical likelihood ratio functions in frames of spatial predictive modelling procedure. Having data on landslide occurrence for 35 years, time-based cross-validation was possible, and the generated susceptibility map was transformed to a hazard model for a given period. The collected data on direct damages due to landslides and corresponding vulnerability provided basis for potential losses estimations in monetary terms and, then, to risk mapping.

The maps of landslide phenomena and potentially endangered areas, which are welcomed by policy makers and stakeholders, often are not appreciated by a local society. As some landslides move imperceptibly downslope, a potential danger is often ignored, the maps are perceived as unjustified and imposed bans are considered too restrictive.

To dispel such reservations, inclinometer monitoring was used to provide better evidence on actual displacements and numerical modelling was performed for evaluating stability conditions of a slope located in a selected zone assigned as hazardous on the elaborated map. To make this example more appealing a focus was on the SW-facing slope (sandstone-shale complexes of Krosno beds) in the Biczyska stream valley, where landsliding was observed in 1974. Since then, the terrain was recognised as stable. The inclinometer readings taken during 20 months (from 13.09.2004 to 13.05.2006) revealed an active slip surface (zone) at the depth of 2.5–3.5 m and cumulative displacement of an order of 72-75 mm. The measured displacement rate has an increasing tendency in spring-summer seasons, declines in autumn-winter period and generally correlates with changes in groundwater level (GWL). The numerical modelling has been carried out using FLAC 2D code based on finite difference method. Simulation of material behaviour comprised a visco-elastic part represented by Burger's model as well as a plastic component described by Coulomb-Mohr law. Although only "average GWL" conditions were concerned, simulations revealed deformations in a near-surface zone which in consequence might result in destroying objects to be potentially located on the examined slope. With this example a complimentary approach to landslide danger assessment is shown.