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Thermo-tectonic history of Variscan post-collisional plutons from the Danubian domain (Romanian Southern Carpathians) as recorded by zircon trace element geochemistry and thermometry

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The Romanian Southern Carpathians show a complicated nappe structure completed during the Alpine orogeny (mid to late Cretaceous), with the Danubian domain (a collection of Neoproterozoic granitoids and metamorphic rocks, Paleozoic metasediment and Mesozoic sediments) situated in the lowermost tectonostratigraphic position, topped by the Severin nappe system (Jurassic ophiolites and associated rocks), and Getic-Supragetic nappe system (pre-Alpine gneisses and sediments), the uppermost unit in the Alpine stack. During the latest stages of the Variscan orogeny, the Neoproterozoic basement of the Danubian domain was intruded by numerous granitoid plutons, preserving ages that indicate important post-collisional magmatic activity.

Ten statistically representative zircon populations from ten different Variscan plutons were studied by means of electron probe micro-analyzer (EPMA) and laser ablation inductively coupled plasma-mass spectrometry (LA ICP-MS). Cathodoluminescence imaging revealed that the majority of the samples are extensively zoned and have strong inheritance. While both cores and rims were analyzed, a clear distinction has been made between them in the graphical representation and interpretation of data.

There is a visible positive correlation between the total trace elemental compositions of the zircons and their ages. Furthermore, ΣREE (ranging between 212 and 2796ppm) is fairly well correlated with temperatures (545 to 755ºC) calculated using the Ti-in-zircon thermometer. However, there is a wide variation in zircon trace elemental composition ($e.g.$, HREE, Sm, Nd, Sr, Hf, Th/U) between the individual plutons, and sometimes within the same pluton. In-pluton variability is frequently correlated with variations in the whole rock geochemistry and petrology with the intrusions. Such variations can be attributed to melting of heterogeneous protoliths (both crust- and mantle-derived) or to variations of the physical parameters ($e.g.$, temperature and pressure,) during melting, which may be linked to a change in the tectonic regimes during orogenic events, such as transition from crust thickening to delamination.

Considering the relatively narrow age window, and the zircons' geochemical heterogeneity, it may be inferred that latest stages of the Variscan magmatism in the Danubian domain was characterized by abrupt changes in the geodynamic setting that could imply intrusion of mantle-derived magmas as a result of crust and mantle decoupling