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Reconstruction of multi-phase fluid flow history and tectonic evolution in a Variscan granite intrusion (Velence Mts., Hungary)

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Hydrothermal fluid flow in and around intrusive and volcanic rocks is forced by fracture related permeability. Fracturation of magmatic rocks is mostly controlled by the regional stress field which will determine the orientation and localization of fluids flow during hydrothermal processes. Mapping and orientation analysis of hydrothermal processes related microfissuring completed with stress tensor analysis and fluid inclusion studies can help us to reconstruct the evolution of permeability and tectonism in hydrothermal altered rocks. The aim of this work is to represent the evolution and the relationship between hydrothermal fluid flow and regional tectonism on a geologically complex area with the help of the Fluid Inclusion Plane (FIP) method. FIP-s are healed microcracks, containing fluid inclusions, which form perpendicular on the extension. Analysis of their orientation, fluid inclusions and density help us to understand the fluid flow properties in microscale. The Velence Mts. (W-Hungary) is a 280-300 Ma old monzogranite body which was affected by several hydrothermal processes as during the Variscan age, related to the late phases of the granitic magmatism, as related the younger Palaeogene magmatism. The granite intrusion related fluid circulation was a high temperature, high pressure process which was followed by a low temperature high pressure deep basin related fluid migration. During the Palaeogene age the granite body was located in the Alpean subduction-collision zone where the granite and its covering Palaeozoic shale was intruded by several andesite dykes and even a stratovolcanic series and a diorite porphyry intrusion developed in the eastern part of the mountains. The high temperature and by low pressure boiling Palaeogene hydrothermal fluids penetrated not only the diorite intrusion - resulting

Cu-porphyry mineralization - and the statovolcanic series - forming epithermal mineralization - but the granite body, as well. To characterize the relationship between hydrothermal fluid flow, tectonic and the interference of the hydrothermal systems regional analysis was carried on open and mineralized macroveins and faults, mineralogical and geochemical measurements (K/Ar radiometric age determination) were made on alteration zones. Fluid Inclusion Plane (FIP) method was applied to analyze the evolution of microfissuring and the evolution of microfracture connected permeability. The relative age of the FIP-s was determined by conventional fluid inclusion studies. Variscan fluids migrated under high temperature, the vapour/liquid ratio in their FI-s equivalent. The Palaeogene fluids boiled under low pressure, FI-s in this generations have different vapour/liquid ratios (40-95%). This textural difference is a key point to distinguish the different fluid generations. In the late magmatic phase of the granite crystallization several NE-SW oriented small aplite and thick granite porphyry dykes intruded the granite body. The first, granite related FIP generation has the same orientation. This first generation penetrated regionally the granite body, in the fluid inclusions of this Fluid Inclusion Assemblage (FIA) no temperature or salinity differences were detected. However the fluid migration was regional, in some tectonically preformed and argillic altered (illite-kaolinite-smectite) zones the Fluid Inclusion Density (Number of FI/Area, and Summa Fluid Inclusion length, FID) was much higher. The NE-SW oriented subvertical quartz veining and parallel FIP-s in this zones and the tensor analysis of faults at this localities proves NW-SE extension for the Variscan age. The deep basin related high salinity fluid migration is less frequent on the basis of the FIP analysis. Orientation of their FIP-s are NW-SE and partly parallel with the former generation. Palaeogene FIA are located in some narrow alteration zones, close to the andesite dykes. The most typical alteration mineral in this zones is the illite which has different K/Ar radiometric ages between 28 and 40 Ma. FID and average length of FIP-s is much higher in this samples, while variscan FIA-s are usually absent. The low pressure but high temperature Palaeogene fluids reheated the granite, and the Variscan intrusions decrepitated owing the high internal and external pressure differences. The decrepitation resulted reopening and connection of old FIP-s, constrained by the existing stress field new FIP were generated. All samples from the Palaeogene zones reserve the orientation of the Variscan FIP directions but new orientations (E-W, N-S) occured at the some places as well. The NW-SE extension was also characteristic for the Palaeogene age, but it also reactivated as dextral fault parallel with the regional Balaton line. The activity of a large Palaeogene normal fault between the Variscan and Palaeogene was established on the basis of FI-s, which later rejuvenated as dextral strike-slip fault. The N-S extension is proved by the E-W oriented FIP-s and by the E-W trend of the hydrothermal centers of the stratovolcanic series and the Palaeogene hydrothermal breccias. The contemporaneous application of the FIP method with stress field analysis of macrofractures, fluid inclusion and geochemical measurements allowed us to depict the evolution of mikrofracture generations and establish the succession of tectonic events.