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Zoning of pegmatite fields as a key for unraveling the internal structure of basement nappes: examples from the Eastern Alps (Austria)

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Many pegmatite fields show a zoning in paragenesis, mineral composition and grade of fractionation of the individual pegmatite bodies. This zoning is mostly due to fractionated crystallization of melt during upward migration from its source region. It can be used for prospecting rare element pegmatites, but also for unraveling the internal structure of metamorphic basement. This contribution presents two examples from the Austroalpine Unit of the European Alps, where mineral distribution and composition as well as fractionation trends give an additional opportunity to determine nappe boundaries more precisely and give hints on the internal structure of individual nappes.

The Austroalpine Unit represents a complex nappe stack formed in Cretaceous time. In the investigated areas around the village of St. Radegund and in the Koralpe Mountains it consists of partly migmatitic micaschist and paragneiss with intercalations of marble, amphibolite and eclogite. Permian pegmatites of variable size and composition are frequent. These rock packages experienced a Permian low pressure metamorphic imprint and a Cretaceous amphibolite to eclogite facies overprint. Based on petrological features the pegmatite occurrences can be attributed to three levels of an idealized rock column. (1) In the lowermost structural level pegmatitic patches, narrow pegmatitic dykes and large feldspar dominated pegmatites occur within migmatitic micaschists and paragneisses. Petrological investigations of the country rocks indicate that they experienced upper-amphibolite facies conditions (∼0.65 GPa – 650°C) at a depth of c. 25 km during the Permian event. (2) Structurally higher domains are characterized by concordant barren pegmatites of several meters thickness, associated in some places with inhomogeneous leucogranitic bodies. (3) Higher evolved spodumene-bearing pegmatites are present in the structurally uppermost level. The parageneses of surrounding micaschists and paragneisses indicate that these pegmatites intruded in upper greenschist facies conditions (∼0.35 GPa – 500°C), corresponding to c. 13 km depth. Gneisses formed from Permian pegmatites are frequent in the basement in the surrounding of St. Radegund. In the southeast, pegmatitic patches and barren pegmatites are situated within biotite rich, medium-grained micaschist showing indications of anatexis. In contrast, at the top of the unit, additional spodumene and beryl occur in pegmatite gneisses, which are situated within staurolite-bearing micaschist. Chemical composition (e.g. K/Rb vs Li or Tl) of cm-sized magmatic muscovite from pegmatite gneisses records increasing fractionation towards the top of the unit which is consistent with the mineralogical evolution and indicates an upright position of the rock package with respect to the Permian situation.

The Plattengneiss Shear Zone represents a major structural element within the eclogite-bearing rocks of the Koralpe Mountains. Below the shear zone, micaschist with dm-sized kyanite pseudomorphs after Permian chiastolitic andalusite occur. Pegmatite gneisses therein contain frequent garnet and tourmaline as well as spodumene at some localities. Within the structural lower part of the Plattengneis shear zone pegmatite mylonites are rich in garnet and tourmaline, whereas those in the upper part are composed only of feldspar and quartz and extremely rarely additional muscovite. This abrupt change delineates the nappe boundary situated within the shear zone.