

PETROLOGY AND GEOCHEMISTRY OF ULTRAMAFIC ROCKS IN THE EASTERN ALPS

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Ultramafic rocks are frequent in orogenic belts. Their early history may be obscured by deformation and metamorphism, which accounts for the uncertainty and controversy about their origin. They either represent fragments of upper oceanic or subcontinental mantle, cumulates of basaltic magmas or are products of ultramafic magmas. The ultramafic rocks of the Eastern Alps, commonly referred as to serpentinites, belong to different tectonic units and show different magmatic and metamorphic evolution histories. These units include the series of the Penninic domain which were overthrust during Alpine orogeny by the basement nappes of the Austroalpine domain.

Samples from ten different localities were selected for a comparative study of Eastern Alpine ultramafic rocks. The Precambrian to early Paleozoic rocks of the Schwarze Wand Ultramafic Complex, the Stubachtal Complex, the Felbertal serpentinite occurrence (all Salzburg) and the Ochsner-Rotkopf Complex (Tyrol) belong to the Prealpine Penninic unit. The Reckner Complex within the Lower Austroalpine Zone and the ultramafic rocks of Blauspitze, Ködnitztal (all Tyrol) and Wurmataler Joch (S-Tyrol) within the Matrei Zone, comprising Pennine and Lower Austroalpine elements, are of Mesozoic age. The occurrences of Hochgrössen, Kraubath and Pernegg (Styria) are part of the early Palaeozoic Speik Complex of the Middle Austroalpine Basement units. Primary igneous structures, especially layers with pyroxene, are recognizable in the Ochsner, Stubachtal and Speik Complex.

Metamorphic ultramafic rocks show a wide range in composition, which is controlled mainly by the absence or presence of normative clinopyroxene. Within the ultramafic rocks of the Speik Complex the dominant rock types are dunites and harzburgites with an Al_2O_3 -content of less 1 wt.%. In Kraubath and Pernegg dunite is more frequent and represents the residue after extraction of basaltic magma. Dikes of olivin-orthopyroxenites crosscutting the peridotite are also present in Kraubath and Pernegg. Some rocks of the Stubachtal and Ochsner massifs are notably different in containing normative clinopyroxene and can be distinguished of the general depleted harzburgites of the Schwarze Wand Complex and Felbertal. Such layers of olivin-websterites and wehrlites may represent ultramafic cumulates formed during magmatic differentiation. These cumulates are characterized by moderate Al_2O_3 -contents of ca. 2.8 wt.% and high CaO reaching 18 wt.%, which corresponds to 67% normative diopside. Comparison of bulk chemistry of the analyzed lherzolites of the Reckner and Blauspitze with the other peridotites demonstrates a clear distinction. The lherzolites have significant high amounts of the magmaphile elements Al and Ti. The high Al_2O_3 - (2.6-4.6 wt.%) and TiO_2 -contents (0.9-0.22 wt.%) are comparable with values of a Primitive Upper Mantle, reflecting low degrees of depletion. REE pattern of Reckner und Blauspitze ultramafics display similar shapes. The samples are slightly LREE depleted (0.1 times chondrites) and represent a relatively undifferentiated, fertile upper mantle. The highly tectonized Wurmatal serpentinites, have in contrast to samples of the Reckner and Blauspitze, lower Al_2O_3 - (1.2-3.2 wt.%) and TiO_2 -contents (0.02-0.11 wt.%). Most of the investigated ultrabasic rocks have been completely serpentinitized. The products of metamorphism are chiefly serpentine minerals accompanied by various combinations of diopside, olivine, tremolite, chlorite, talc, brucite and magnetite. In the lherzolitic samples of Reckner and Blauspitze relict clinopyroxene may exceed an Al_2O_3 -content of 7 wt.% and a Na_2O -concentration of 1.5-2.0 wt.%. Magmatic olivine is restricted to samples of the Speik Complex. Compared with the metamorphic olivine ($x_{\text{Mg}} > 96$), these have low x_{Mg} -values of 0.85-0.90 and higher NiO-contents of 0.25-0.40 wt.%. Orthopyroxene occurs in Kraubath and Pernegg with a composition varying from 6-10 mol% of ferrosilite solid solution. Chromite in the metamorphic ultramafics is extremely variable in composition. Spinels of the Reckner show intermediate Cr-values of 40-50, typical for lherzolite subtype, whereas chromites from the Speik Complex are predominantly rich in Cr with Cr# 0.73-0.95. However, the Kraubath and Pernegg spinels are characterized by lower Mg-values of Mg# 20-50 than those of Hochgrössen.