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Variable mineral composition of metamorphic rocks from a single quarry compared to their ASR potential (Bohemian Massif, Czech Republic)

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The alkali-silica reaction (ASR) is one of the most damaging factors for concrete structures. ASR originates due to the presence of reactive silica (SiO_2) that reacts with alkaline ions under wet conditions. The reaction mechanism consists of four different steps: initial attack of OH- compounds on SiO_2 at aggregate-cement paste boundary; formation of silanol groups at SiO_2 surface; formation of siloxane groups and their polymerization; adsorption of alkaline and Ca2+ ions and formation of alkali-silica gels. Alkali-silica gels tend to absorb water molecules and swell causing increasing internal pressures in concrete and microcracking. The most reactive aggregates are mainly composed of amorphous and/or fine-grained SiO_2-rich phases. In the Czech Republic, ASR was observed in deteriorating concrete structures containing very fine-grained quartz (quartz in tuffaceous sandstones and greywackes), as well as quartz indicating variable degree of deformation (quartz in quartzite, granodiorite and various metamorphic rock types).

In this study, mineralogical-petrographic methods (polarizing, electron and cathodoluminescence microscopy) were combined with the accelerated mortar bar test (following the standard ASTM C1260), with the aim to quantify the ASR potential, as well as to distinguish reactive mineral phases. Different aggregate varieties from the Těchobuz quarry (Moldanubian Zone, Czech Republic) have been compared. Mineralogical-petrographic characteristics permit a distinction between 1) medium-grained plagioclase quartzite and 2) fine-grained biotite-plagioclase-quartz paragneiss and 3) fine-grained calc-silicate rock. Mineralogical composition of the first type is quartz + Ca-plagioclase + K-feldspar + biotite + chlorite + diopside + pyrite + apatite + titanite $\pm$ calcite. The second type has mineral assemblage including quartz + Ca-plagioclase + K-feldspar + biotite + chlorite + pyrite + tourmaline + apatite + titanite $\pm$ calcite. The third type contains quartz + calcite + Ca-plagioclase + diopside + amphibole+ clinozoisite + muscovite + K-feldspar + pyrite + apatite + titanite + zircon. Alkali-silica reactivity of aggregate types was quantified based on the expansion of mortar bar specimens. Investigated samples display the expansion above 0.1 % and thus are classified as reactive. Variable reactivity is mostly caused by the presence of quartz characterized by different degree of deformation and grain size. Calcite and mafic minerals exhibit no ASR potential. The role of feldspars would be discussed due to possible leaching of alkalis into a solution.