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SPECIAL COLLECTION: WATER IN NOMINALLY HYDROUS AND ANHYDROUS MINERALS

OH defects in quartz as monitor for igneous, metamorphic, and sedimentary processes

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Abstract

Oriented sections of more than 500 quartz grains from sediments, igneous, and metamorphic rocks from different localities in Sweden, Austria, Germany, and South Africa were analyzed by FTIR spectroscopy, and their OH defect content was determined with respect to the speciation and total defect water content. Systematic variations of defect speciation and statistical evaluation of total defect contents were used to evaluate the potential of FTIR spectroscopy on quartz as a thermometer in quartzite, as a tool for differentiation trends in granitic systems, and for provenance analysis of sedimentary rocks. In addition to the analyses of natural crystals, high-pressure annealing experiments at lower crustal conditions (1–3 kbar and 650–750 °C) were performed to document the effect of high-grade metamorphism on the defect chemistry. Results indicate that (1) quartz grains from unmetamorphosed granite bodies reveal interesting differentiation trends; (2) sediments and sedimentary rocks are valuable archives to preserve the pre-sedimentary OH defect chemistry, where individual signatures are preserved and can be traced back to potential source rocks; (3) OH defects are retained up to 300 °C over geological time scales; (4) long-term low-grade metamorphic overprint leads to a continuous annealing to lower defect water contents, where Al-specific OH defects survive best; and (5) middle to high-grade annealing drives toward a homogeneous defect partitioning from grain to grain, where the degree of attainment of equilibrium depends on temperature and duration of the thermal event.

In summary, OH defects in quartz crystals monitor parts of their geological history, and the systematic investigation and statistical treatment of a large amount of grains can be applied as an analytical tool to study sedimentary, metamorphic, and igneous processes.

Keywords: Quartz, hydrous defects, provenance, quartzite, granite