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An FTIR study of hydrogen in anorthoclase and associated melt inclusions

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ABSTRACT

High-resolution Fourier transform infrared (FTIR) spectroscopy has been used to document the presence of hydrogen, to estimate its concentration, and to document its oxygen speciation in anorthoclase crystals and associated melt inclusions from Mount Erebus, Antarctica. Synchrotron-generated infrared radiation, 100 to 1000 times brighter than globar-generated infrared radiation, permits rapid collection of maps that depict relative intensities of a chosen FTIR band across the mapped area. Spectra and/or compositional maps showing variations in water concentration were collected from anorthoclase megacrysts and melt inclusions in the megacrysts. Studies of anorthoclase megacrysts involved collection of spectra from three mutually perpendicular sections cut from the crystals. FTIR spectra of anorthoclase crystals are characterized by a broad absorption band at approximately 3200 cm^{-1} in the mid-IR range. The universal mass absorption coefficient for mid-IR range feldspar spectra, established by Johnson and Rossman (2003), was used for quantitative estimates of water concentrations in the feldspar crystals based on integrated area under the 3200 cm^{-1} band. Water concentration in the anorthoclase sample was approximately 126 ppm, with an overall error of approximately ±30%. FTIR spectra of melt inclusions are characterized by a broad asymmetric absorption band at ~3550 cm^{-1} that was used to calculate total water concentration. The absence of a band at 1630 cm^{-1} suggests that water in the melt inclusions occurs as OH^- rather than as molecular H_2O. Absorption coefficients established by Mandeville et al. (2002) for H species in glass were used to calculate water concentrations in the melt inclusions. Melt inclusions in the Mt. Erebus anorthoclase have water concentrations ranging from 0.12 to 0.39 wt%, with an overall error of approximately ±15%. The ratio of water in anorthoclase crystals to water in the melt from which the crystals formed, based on this study, and at these low melt water concentrations, is approximately 1:10. However, water concentration varies significantly from one melt inclusion to another, possibly suggesting initial melt water heterogeneity. Maps of water concentration show that variations in water concentration within melt inclusions are associated with fractures that cut the melt inclusions and in some cases do not extend out into surrounding crystals or into crystal inclusions. Thin (~50 μm thick) zones of elevated water concentrations on the boundaries of the crystals in contact with melt inclusions suggest that water has diffused into the crystals from the melt inclusions.

Keywords: Water, FTIR spectroscopy, anorthoclase, Mt. Erebus