HIGH QUARTZ DISSOLUTION RATES AT LOW PH

MITRA, Arijit, Dept. of Geosciences, Virginia Tech, Blacksburg, VA 24061

We have found that quartz dissolution rates increase significantly below pH 3, although there is good evidence that the dissolution rate of quartz is unaffected by pH between 3 and 7. My results show that the dissolution rate of quartz at pH 0 is nearly two orders of magnitude faster than the dissolution rate at pH 3. At least five other studies have documented similar fast rates at pH < 3 at temperatures ranging from 25°C to 200°C. The significantly higher dissolution rates can either be attributed to additional aqueous species such as $H_5SiO_4^+$ or to a reaction mechanism where the rates are catalyzed by hydrogen ions. My experiments using different acids suggest that the faster dissolution rates are not an anion effect

Pure crystalline quartz from various sources was used for these experiments. Hydrochloric acid, sulfuric acid, nitric acid, and perchloric acid were used to titrate the pH between 0 and 7 and the dissolution rates were comparable for all acids. The dissolution experiments were conducted in batch reactors at a constant temperature of 25 (±1) °C. For each experiment, a known mass of quartz with measured BET surface areas was placed in a Teflon reactor with 25 mL of solution and incubated for 2 to 10 days. Prior to the experiments the "disturbed surface layer" was removed from all samples by leaching the quartz grains in boiling distilled water for 14 days using a Soxhlet extraction apparatus. Samples were taken periodically over the duration of the experiment and their silica concentration was determined by the silicomolybdate blue colorimetric method. The dissolution rate was calculated using the initial rate method.

These faster quartz dissolution rates at low pH may have various geological and technological implications. For example, in the etching of semiconductor chips with HF, the etching process may be partly controlled by H^+ activity along with HF activity. Although this effect may not have been recognized in natural environments because such low pH conditions are uncommon, but it might be of importance in oxidized vapor dominated geothermal systems, acid crater lakes, and acid mine drainage settings.

Advisor: Dr. J. D. Rimstidt