A method for determining the solubility of water in silicate melts

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Abstract

The method described in this paper for determining the solubility of water in silicate melts consists primarily of locating the boundary (or projected boundary) between the field of liquid and the field of liquid + gas in successive isobaric T-X$_{H_2O}$ sections for a given system. It involves the sealing of known amounts of water and silicate starting material in noble-metal capsules, the fusing and homogenization of these charges in pressure vessels, equilibration at designated experimental run temperatures and pressures, and quenching after prescribed periods of time. The quenched products are then examined for evidences of excess water. In determining solubility values from the results of critical runs, corrections are made for aqueous bubbles initially trapped and subsequently preserved within the charges, i.e., for water effectively unavailable for solution in the melt. An alternate method involves locating, also in successive isobaric T-X$_{H_2O}$ sections for a given system, the boundary (or projected boundary) between the field of liquid and the field of liquid + crystals. This method generally yields results that are less satisfactory, owing chiefly to the moderate slopes of this boundary for many systems and to difficulties in obtaining the precise control and measurements of temperature that are required. The solubility of water in melts derived from albite glass and Harding, New Mexico, pegmatite have been determined by the excess-water method as a function of pressure up to 10,000 bars and at temperatures of the H$_2$O-saturated liquidus for each melt. Solubility values for the pegmatite melt are 4.2 wt % at 1000 bars and 655 degrees C., 6.6% at 2000 bars and 635 degrees C., 11.2% at 5000 bars and 650 degrees C., and nearly 20% at 10,000 bars and 675 degrees C. Corresponding values for albite melt are 4.2 wt % (930 degrees C.), 6.4% (850 degrees C.), 9.9% (750 degrees C.), and 16.8% (700 degrees C.). The temperature coefficient of water solubility in Harding pegmatite melt, at a pressure of 1000 bars, is about -0.2 wt % of water per 100 degrees C. rise in temperature through the range 650 degrees to 850 degrees C. The solubility values obtained in these investigations are substantially lower, at pressures up to about 4500 bars, than values reported by Goranson for comparable materials on the basis of his weight-loss-ignition method. However, they are much higher, at pressures above 5000 bars, than values derived by the most reasonable extrapolations of Goranson's results to these higher pressures. The discrepancies are attributed mainly to aqueous bubbles that normally are trapped and preserved in the experimental charges; these bubbles evidently were reckoned as dissolved water in the earlier work on albite and granite melts, which would account for pressure-solubility curves of seemingly incorrect position and shape.
melts can dissolve wt. % levels of S, then aubrite oldhamite may well have crystallized directly from silicate melts. Moreover, demonstration of high CaS solubility in silicate melts would strongly rule against aubrite oldhamite being a relict since protolith oldhamite would dissolve in the silicate melt. We have conducted melting and CaS-saturation experiments on a natural E chondrite starting composition [Indarch (EH4)] to determine the solubility of CaS and S in aubrite melts and gather further information on the partitioning of REE’s (La) between oldhamite and sili... Effects of F, B2O3 and P2O5 on the solubility of water in haplogranite melts compared to natural silicate melts...