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DISCUSSION AND REPLY

SOLUBILITY OF WATER IN ALBITE-MELT DETERMINED BY THE WEIGHT LOSS METHOD: A DISCUSSION[1]

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INTRODUCTION

In a recent re-publication of the results of water solubility determinations using the weight-loss method, Hamilton and Oxtoby (1986) have devoted considerable space to criticism of the method of determination of water solubilities employed by Dingwell et al. (1984). In this comment we wish to respond to the criticisms of Hamilton and Oxtoby (1986).

VACUUM FUSION MANOMETRY

In the study by Dingwell et al. (1984), the solubility of water in several haplogranitic melts was determined using the vacuum fusion manometric system developed by Harris (1981). The method involves four essential steps: (1) a water-saturated melt is synthesized, (2) a bubble-free sample of quenched glass is obtained, (3) a weighed sample of the glass is fused in a vacuum and the evolved gas is collected in a liquid nitrogen cold trap, and (4) the collected gas is liberated from the cold trap and the pressure exerted by the gas in a known measuring volume is recorded. The amount of gas liberated is readily computed and compared with the mass of the glass sample to obtain a solubility value.

COMMENTS OF HAMILTON AND OXTOBY

Hamilton and Oxtoby (1986) make two criticisms of the method of Dingwell et al. (1984).

First, they point out that our weighing error of ± 0.003 mg yields a value of ± 15% for our smallest sample size of 0.020 mg [misreported by Hamilton and Oxtoby (1986) as 0.6 mg]. The range of glass sample masses used by Dingwell et al. (1984) was indeed from 0.020 to 0.600 mg *but*, with the exception of NOR composition, all glass wafers were greater than 0.100 mg thus yielding weighing errors of less than ± 3%. In addition, NOR was analyzed in duplicate with a second wafer weighing 0.072 mg (weighing error = 4.2%). In fact, more than half of the samples were > 0.200 mg. Finally, on this point, general criticism of the data of Dingwell et al. (1984), based on sample size, is irrelevant because the method itself is not, in general, restricted to small samples.

Second, Hamilton and Oxtoby (1986) express concern over the methods of sample handling employed by Dingwell et al. (1984) prior to their fusions. We were indeed concerned about possible water loss or gain during the sample-handling and tested the possibility of handling errors in the following manner. The most peralkaline glass, EAK, was relatively vesicle-poor due to its lower viscosity and chips of vesicle-free glass suitable for analysis were readily obtainable directly from the experimental charge. As a check against water loss or gain during our routine sample-handling technique, an unground chip of vesicle-free EAK glass was loaded into the vacuum fusion system, analyzed and compared with the results of runs with glass wafers. The comparison yielded an excellent agreement, illustrating that the preparation method was not destructive with respect to water content. Also, on this second point, the very good precision observed by Dingwell et al. (1984) for sample wafers of varying mass, aspect ratio, initial vesicularity and final thickness (all factors which might

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scatter replicate determinations if the physical handling of samples were a problem) further demonstrates the insensitivity of the water content to the sample handling.

ADVANTAGES OF VACUUM FUSION MANOMETRY

The vacuum fusion manometric method of determining volatile solubilities has advantages over the weight-loss technique.

First, as demonstrated by Dingwell et al. (1984), the method is applicable to a wide range of sample sizes. The main advantage is the extension of the lower limit of the range of sample sizes. The weight-loss technique is limited to larger samples (Hamilton and Oxtoby 1986). The study of Dingwell et al. (1984) was designed to demonstrate the utility of the vacuum fusion manometric method for dealing with water solubility at the low pressures (less than 2 kbars) and low temperatures (800°C) relevant to the petrogenesis of many silicic rocks. This P-T-X region of water solubility determinations had been previously neglected. Thus the vacuum fusion manometric method is effective for, but not restricted to, a range of smaller sample sizes.

Secondly, the liberation of gases from the cold trap of the vacuum fusion system results in a stepwise collection and measurement of the gas content of samples which have more than one dissolved volatile species. The work of Harris (1981) has illustrated that this method can be used for the determination of volatile solubilities in water + carbon dioxide-bearing samples. The weight-loss method, in contrast, is a "blind" technique. The identity and proportions of the gas(es) evolved during drying of complex samples is unknown.

CONCLUSION

In conclusion, we wish to emphasize that the vacuum fusion method of analysis of quenched glasses for dissolved gases is an extremely versatile and precise technique that has been successfully applied to water solubility in the system haplogranite-water. In addition, similar methods of analysis have found use in the calibration of the infrared spectroscopic technique for water determinations in water-undersaturated glasses. Conversely, the weight-loss technique is restricted in P-T-X(-time) space to a region outside of vesicular materials. The method is "blind" to the identity of the gas being driven off and is thus restricted to relatively simple, single volatile systems.

Ultimately, what is required of each of the several methods of solubility determination that have been employed (Dingwell 1986) is that the various methods yield similar results. In order that this may be evaluated, a series of standards of water-bearing glasses are required for distribution and analysis.

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