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The effect of anhydrous composition on water solubility in granitic melts

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ABSTRACT

The effect of anhydrous composition on the solubility of water in granitic melts was investigated experimentally at 800 °C and pressures from 50 to 500 MPa. Starting materials were ten natural obsidians from various localities worldwide and one re-melted leucogranite from the Himalayas.

Most of the experiments were performed in externally heated pressure vessels using Ni-NiO to buffer f_{O_2}. All samples were quenched isobarically after reaction for 120–336 h. Water contents of the resulting glasses were determined by Karl-Fischer titration.

The solubility data indicate that Na/K ratio and normative Qz content have only a minor effect on water solubility, whereas the (MCLNK-A)/O parameter, defined as 100·(2Mg + 2Ca + Li + Na + K–Al)/total oxygen, has a major effect. A parabolic law expressed as the mole fraction of H_2O in the melt on a one-oxygen mole basis is proposed to describe the compositional dependence of water solubility in the range 50–200 MPa:

$$X_{H_2O} = X_{H_2O}^0 \cdot (1 + 0.05 \cdot \{[(\text{MCLNK-A})/\text{O}] - 0.5\}^2)$$

Minimum mole fractions of water in the melt ($X_{H_2O}^0$) are 0.0521 at 50 MPa, 0.0757 at 100 MPa, and 0.1069 at 200 MPa. The equation fits water solubility data for granitic and phonolitic melts at 100 MPa and 200 MPa to within ±4% relative. The effects of anhydrous composition on water solubility are much more pronounced at 500 MPa than at lower pressures. Thus, the following expression was derived to represent the effects of anhydrous melt composition on water solubility at 500 MPa:

$$X_{H_2O} = 0.1681 \cdot (1 + 0.13 \cdot \{[(\text{MCLNK-A})/\text{O}] - 0.5\}^2).$$