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Determination of H_2O-saturated solidus of rock systems by electrical conductivity jump with albite as an example

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Water influences subduction zone processes in many different ways, among which the most important effect is promoting arc magmatism by depressing the solidus of crustal and mantle rocks. However, there has been much debate on slab dehydration against slab melting, as well as on flux melting of the mantle wedge against metasomatism and a prolonged period of storage and heating before mantle melting[1-2]. H_2O-saturated solidus of rock is critical to the debate. Unfortunately, there is significant discrepancy in H_2O-saturated solidus between different experimental studies, mainly due to the difficulty in distinguishing hydrous melt from aqueous fluid in quenched experimental products[3]. To solve this problem, we developed a new approach to locate H_2O-saturated solidus of rock systems by monitoring electrical conductivity of the system in situ. A mixture of albite and >10 wt% H_2O was heated stepwise in the range of 0.35-1.7 GPa in a piston cylinder apparatus. A jump of electrical conductivity (up to 1.8 log units) was observed over a small temperature interval (10-20°C, Figure 1). The temperature corresponding to the electrical jump decreased from 790±10°C at 0.35 GPa to 640±10°C at 1.7 GPa, in good agreement with previously reported H_2O-saturated solidus of albite[4] (Figure 2). Examination of the experimental products quenched immediately after observation of the electrical conductivity jump confirmed the occurrence of albite melting. Our experimental results suggest that electrical conductivity jump serves as a good indicator for rock melting under H_2O-saturated condition, and this in situ approach can overcome the ambiguity in phase identification in quench experiments. With further improvement in water sealing, this new approach has the potential to solve the discrepancy over H_2O-saturated solidus of a variety of rock systems and shed light on subduction zone processes.

Reference

[1] Grove, Till & Krawczynski (2012), Annual Review of Earth and Planetary Sciences, 40, 413-39.

[2] Green, Hibberson, Kovács & Rosenthal (2010), Nature, 467, 448-504.

[3] Green, Hibberson et al. (2014), Journal of Petrology, 55, 2067–2096.

[4] Makhluf, Newton, & Manning (2020), Contributions to Mineralogy and Petrology, 175, 76.

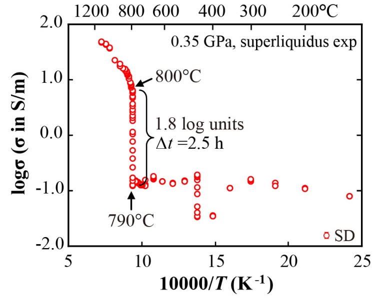

Figure 1. Electrical conductivity of the albite-H_2O system at 0.35 GPa

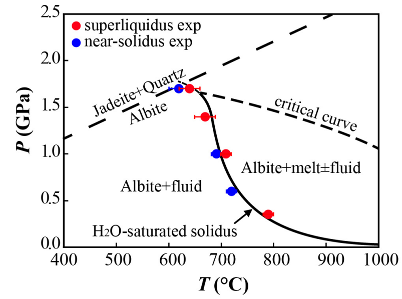

Figure 2. Phase relations of the albite-H2O system. Experimental results are in good agreement with the solidus curve in Makhluf et al. (2020).