Determination of water content of natural talc: application to a recipe for hydrogen manometry

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Hydrogen manometry is a conventional yet powerful, absolute technique for the determinations of water contents of rocks and minerals. The concentration of water in a stoichiometric pure talc was determined by the hydrogen manometry technique so that accuracy of this technique was assessed. The talc sample was from Haicheng mine, China. Bulk chemical composition of the talc sample is ($Mg_{2.930}$, $Fe_{0.001}$) ($Si_{4.003}$, $Al_{0.002}$) on the anhydrous 11 oxygen basis (Matsumura Sangyo Co., Ltd., pers. comm.), which is nearly identical to that of the ideal talc $Mg_3Si_4O_{10}(OH)_2$. Powder X-ray diffraction also shows that the sample consists thoroughly of talc, free from any possible impurity.

About 20 mg of the <38um size fraction of the talc sample was loaded in a Pt crucible and sealed in a quartz-glass reaction vessel. The reaction vessel was then connected to a high vacuum line, and the Pt crucible was heated to 1000 ˚C at the rate of ~1 ˚C/sec using an induction furnace to let the talc sample completely degassed. Degassing was monitored with a Pirani gauge. Degassing from the talc started at around 500 ˚C and ended by 800 ˚C. During the degassing, the released gas was continuously sublimated using liquid nitrogen, so that the gas pressure buildup in the vacuum line was kept not to exceed 10 Pa. The H_2O was cryogenically purified using an acetone - solid CO_2 mixture slurry, and then converted to H_2 gas in a deleted uranium furnace at 700 ˚C. The H_2 gas was transferred into a calibrated volume with a Toepler pump, and the pressure of the H_2 gas was determined. Complete thermal decomposition of the talc to enstatite + amorphous silica was confirmed by X-ray diffraction of the residue after degassing. Repeated measurements of the talc sample yielded H_2O content of 4.71 ±0.05 wt%. This value agrees with 4.75 wt% H_2O of the ideal talc $Mg_3Si_4O_{10}(OH)_2$ within analytical uncertainty.

The gas pressure buildup in the vacuum line could reach an order of kilopascal (one hundred times more than that in the present study) if the released H_2O gas was not continuously sublimed during the degassing process. Clog et al. (2012; Geochim. Cosmochim. Acta 83, 125-137) showed that at high temperatures under such high H_2O gas pressure, a large fraction of the H_2O gas (up to 20%) is retained in the coexisting Pt alloy, which results in a poor yield of the gas in the hydrogen manometry. Diffusion flux of H_2O (H) into Pt metal is proportional to square root of the pressure of surrounding H_2O gas. Results of the present study suggest that holding H_2O gas pressure at less than 10 Pa is a key to have accurate data from the hydrogen manometry.

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