

## Supporting information

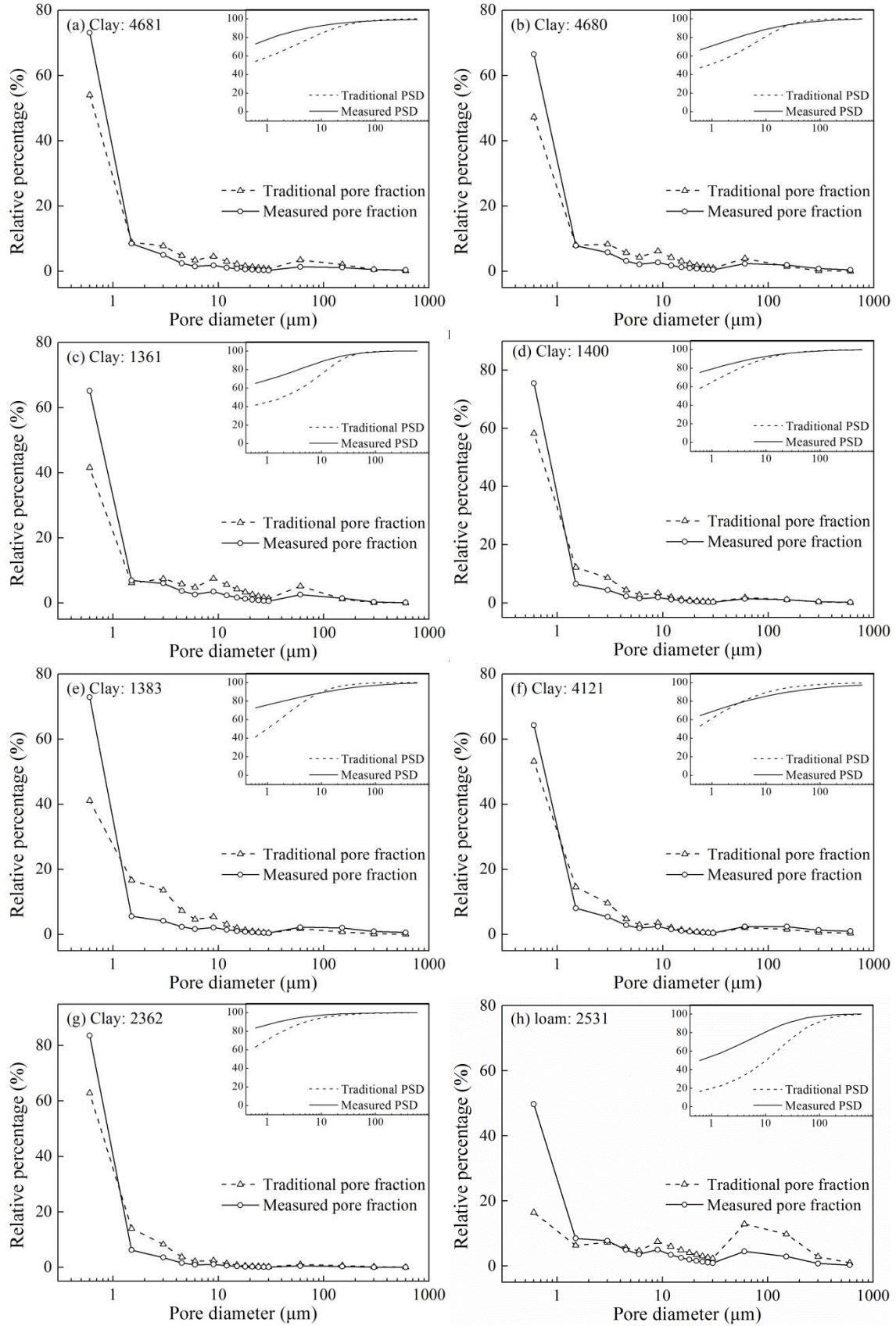
### 1 Introduction

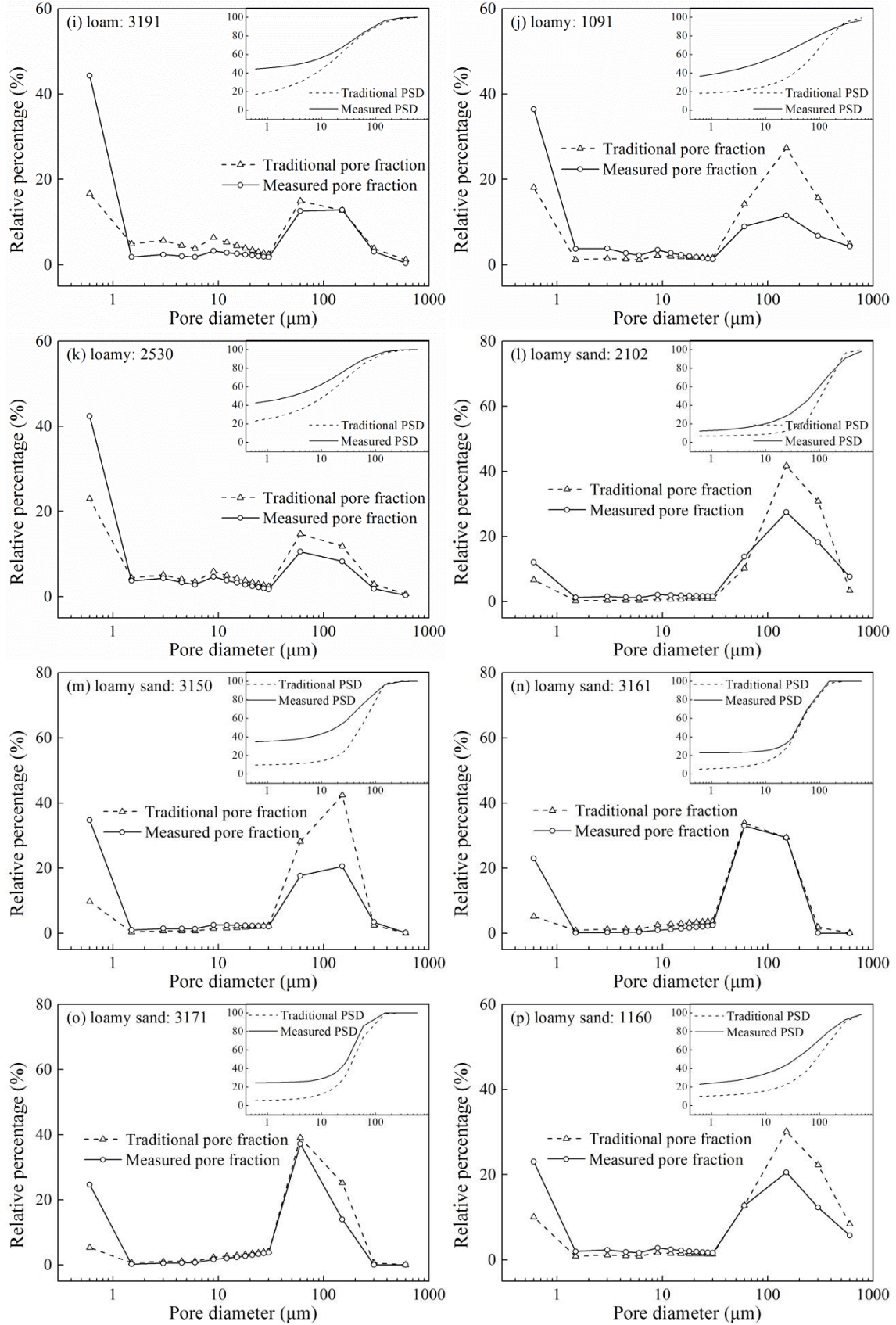
The basic data that the water retention, particle-size distribution and bulk density of samples was selected from the UNSODA hydraulic properties database. In order to reveal the rationality of the results obtained from analyzing plentiful data, the results of samples which were not listed in in main manuscript were presented here as the figures below.

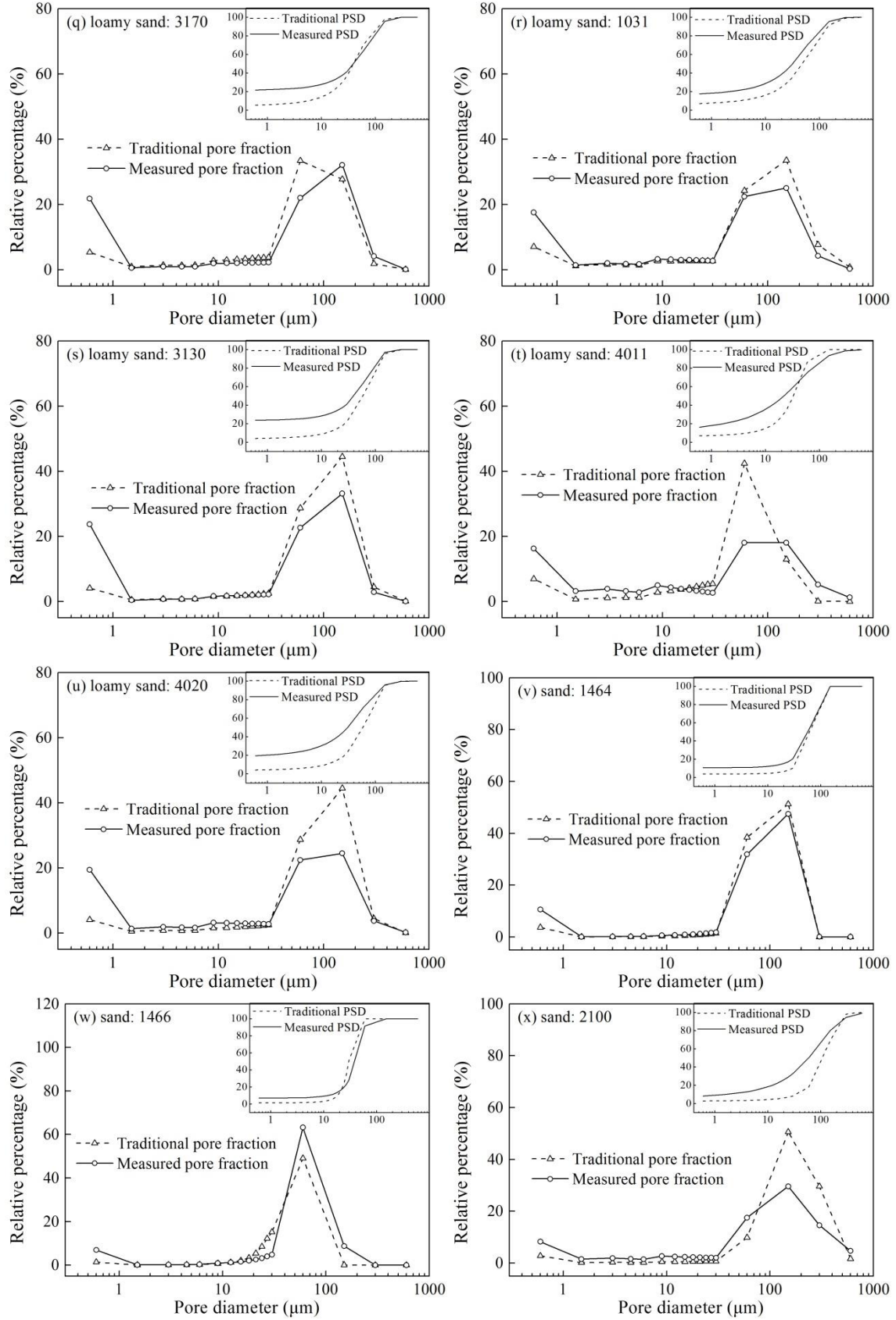
Figure S1 exhibited measured pore volume fraction curves and calculated curves using the traditional model of 46 samples (a-tt), corresponding PoSD curves were presented in the small maps embedded in Fig. S1. The relationship between calculated PoSD and measured ones for all samples here were accordance with the description in the main manuscript. However, for some samples, slightly deviation occurred on pore volume fraction curves, such as loam (code: 4011), sand (code: 2100, 1023, 4162) and all silt loam samples, this was mainly because the measurement error of the PSD and SWC data. But the curves of all silt loam had the same tendency which deviated from the law described in main manuscript and were not only attributed to the measurement error, probably the assumption of the shape similarity between the SMC and the PSD was inapplicable for this type of samples and need further study.

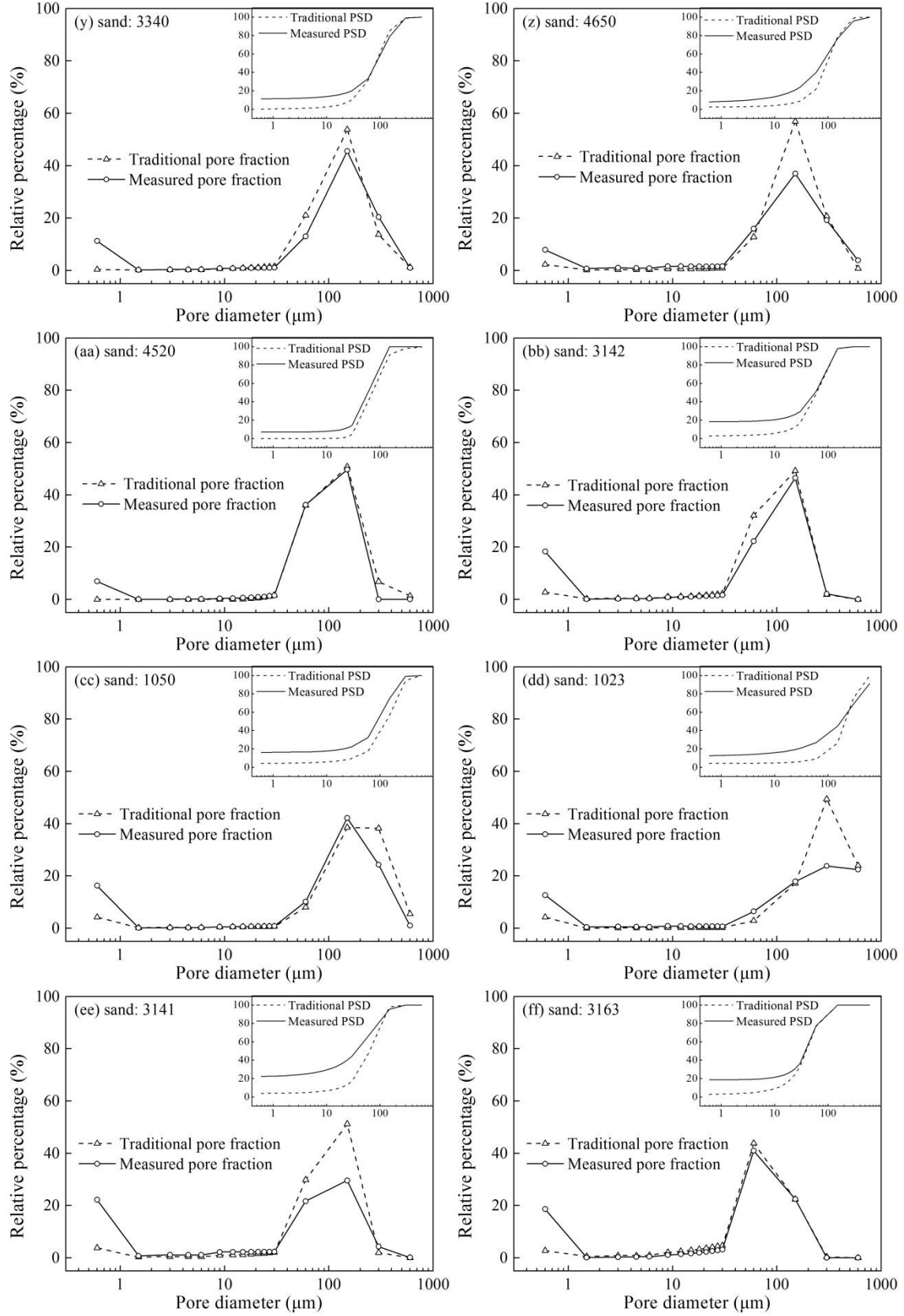
The important parameters  $\alpha$  and  $\beta$  were obtained using the calculation procedure in improved method and the measured water retention and physical properties of 48 samples. The measured and calculated SWC and appropriate parameters of 48 samples were presented in Fig. S2 (a-vv).

The improved method was tested on 22 samples. Except the 4 samples presented in the main manuscript, the measured and predicted SWC using traditional method and improved method of other 18 samples (a-r) were presented in Fig. S3.

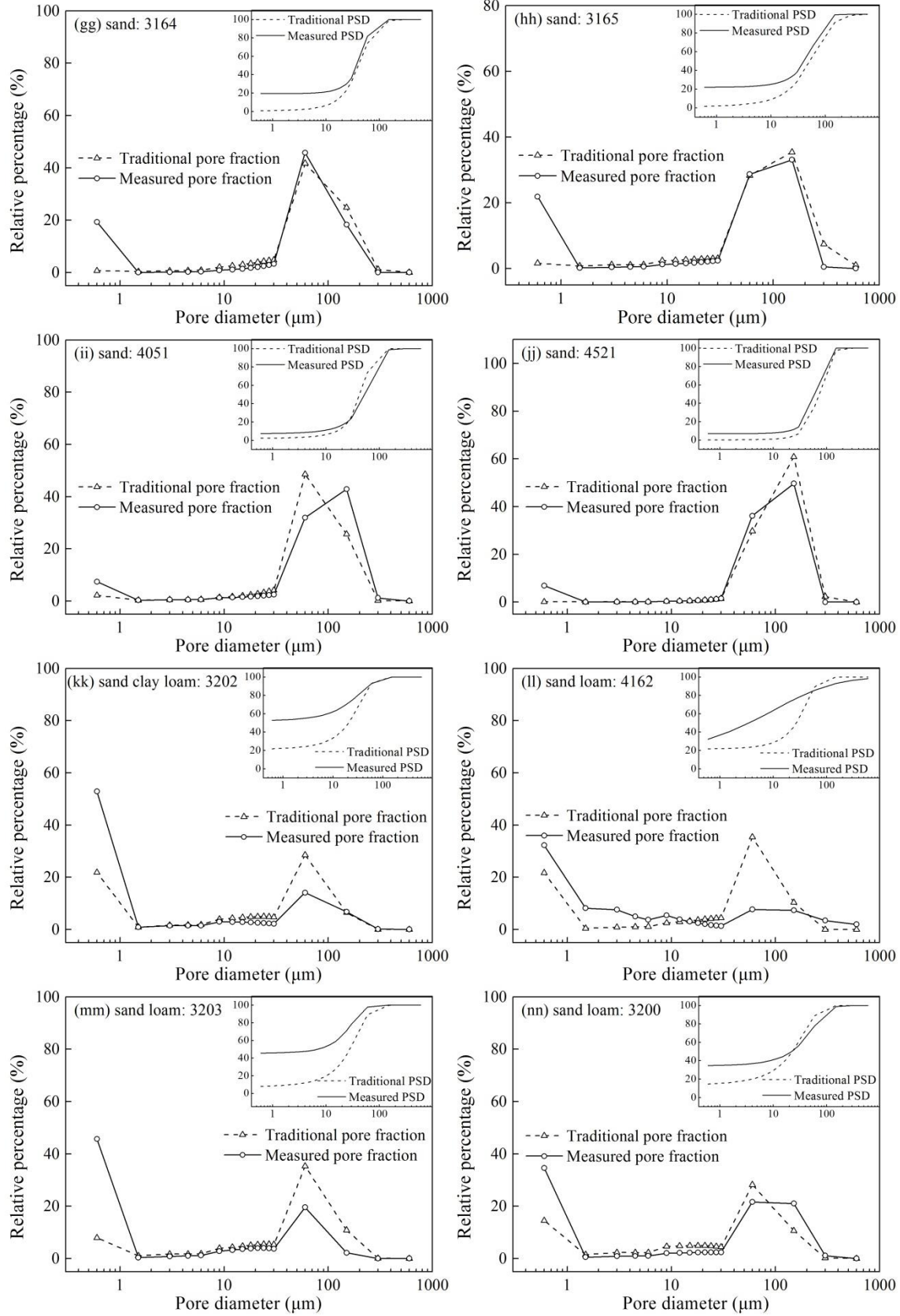


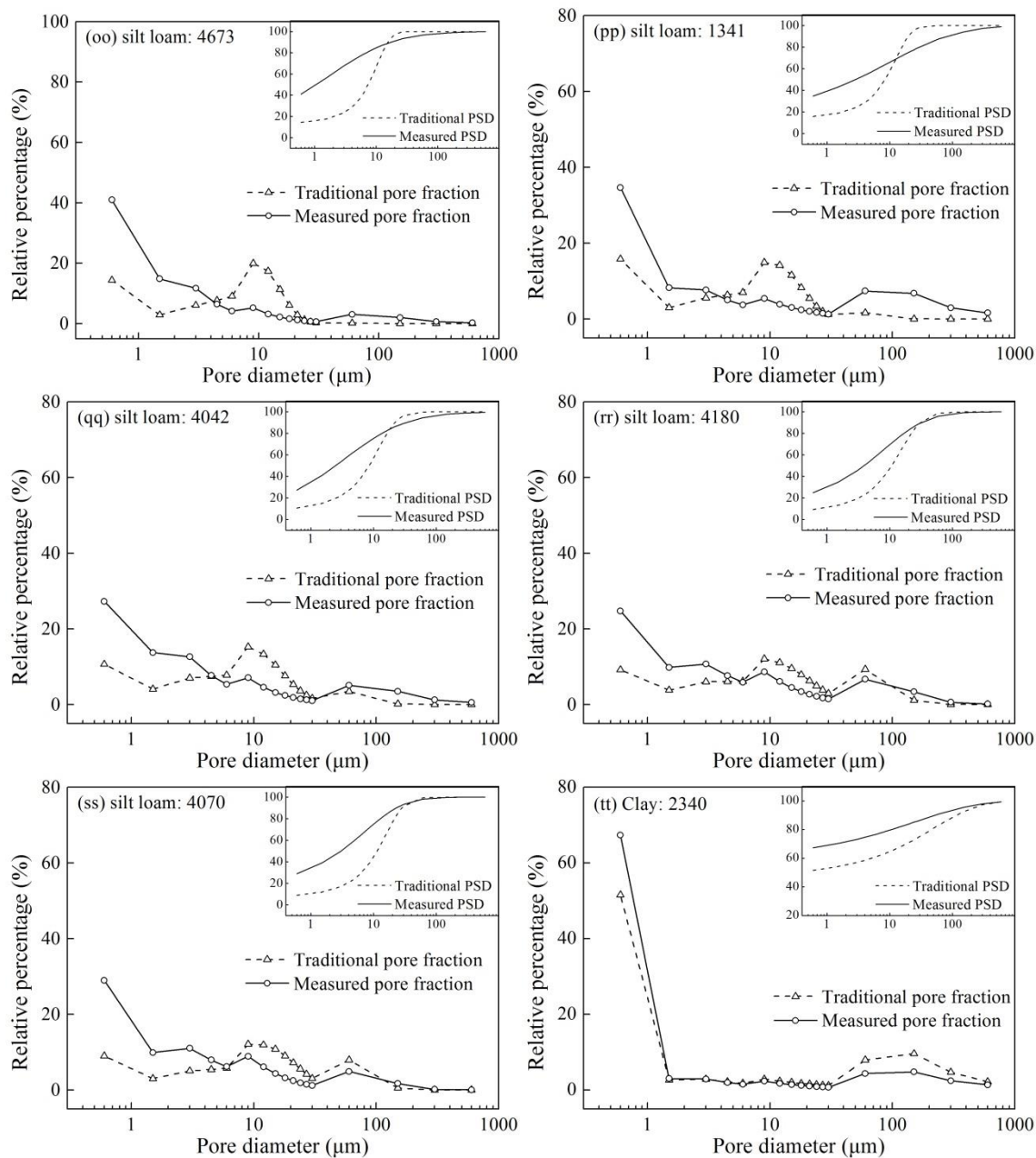




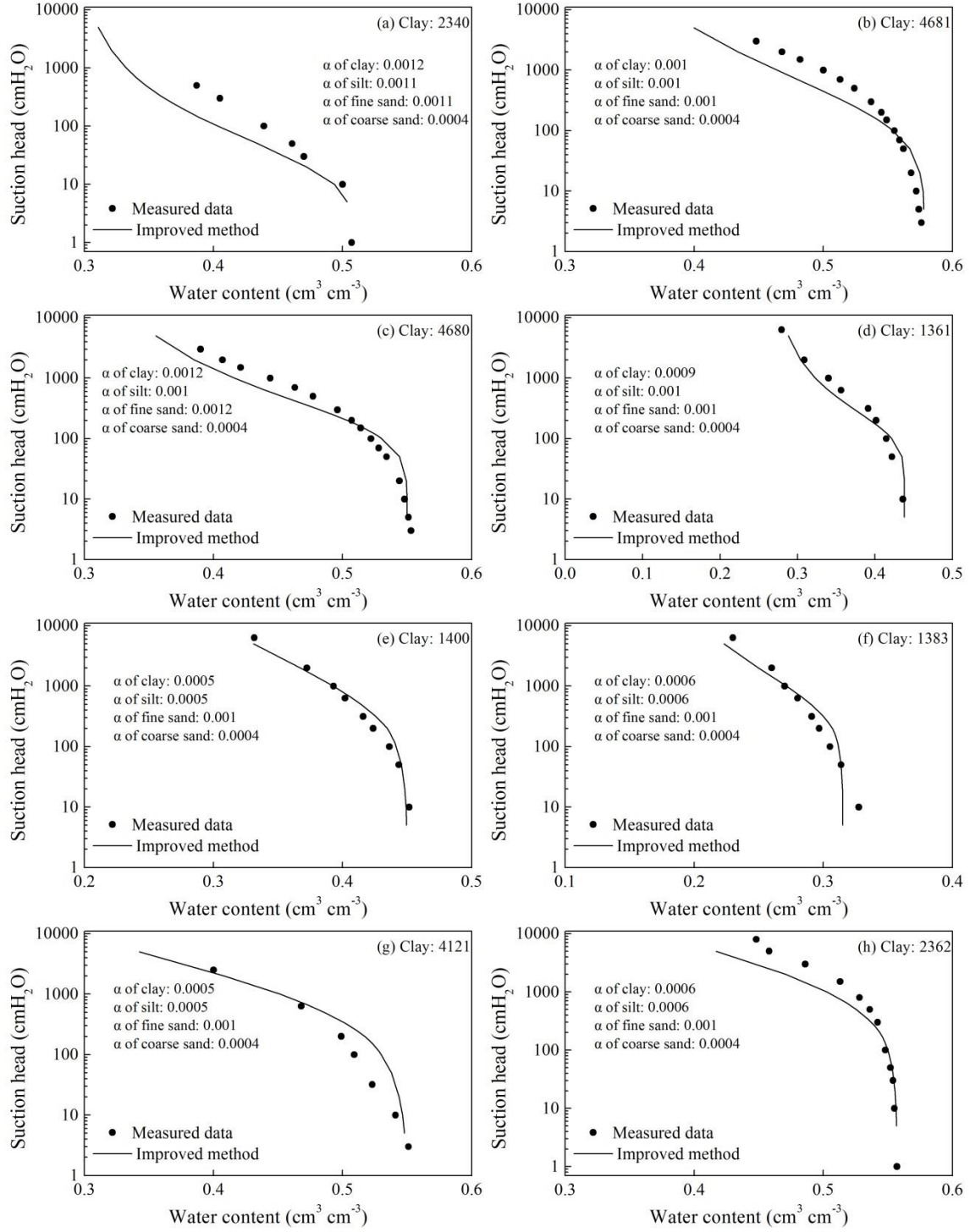




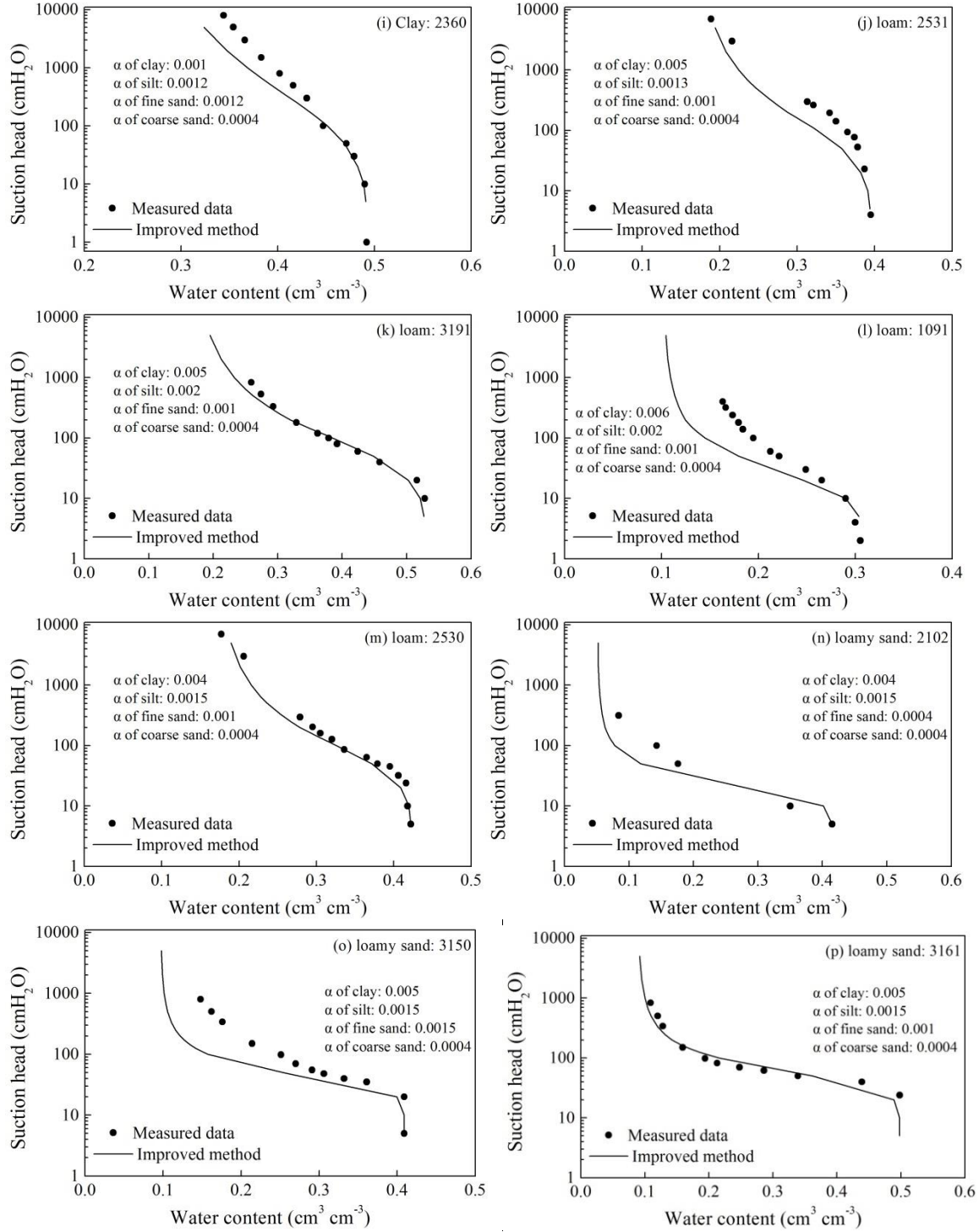


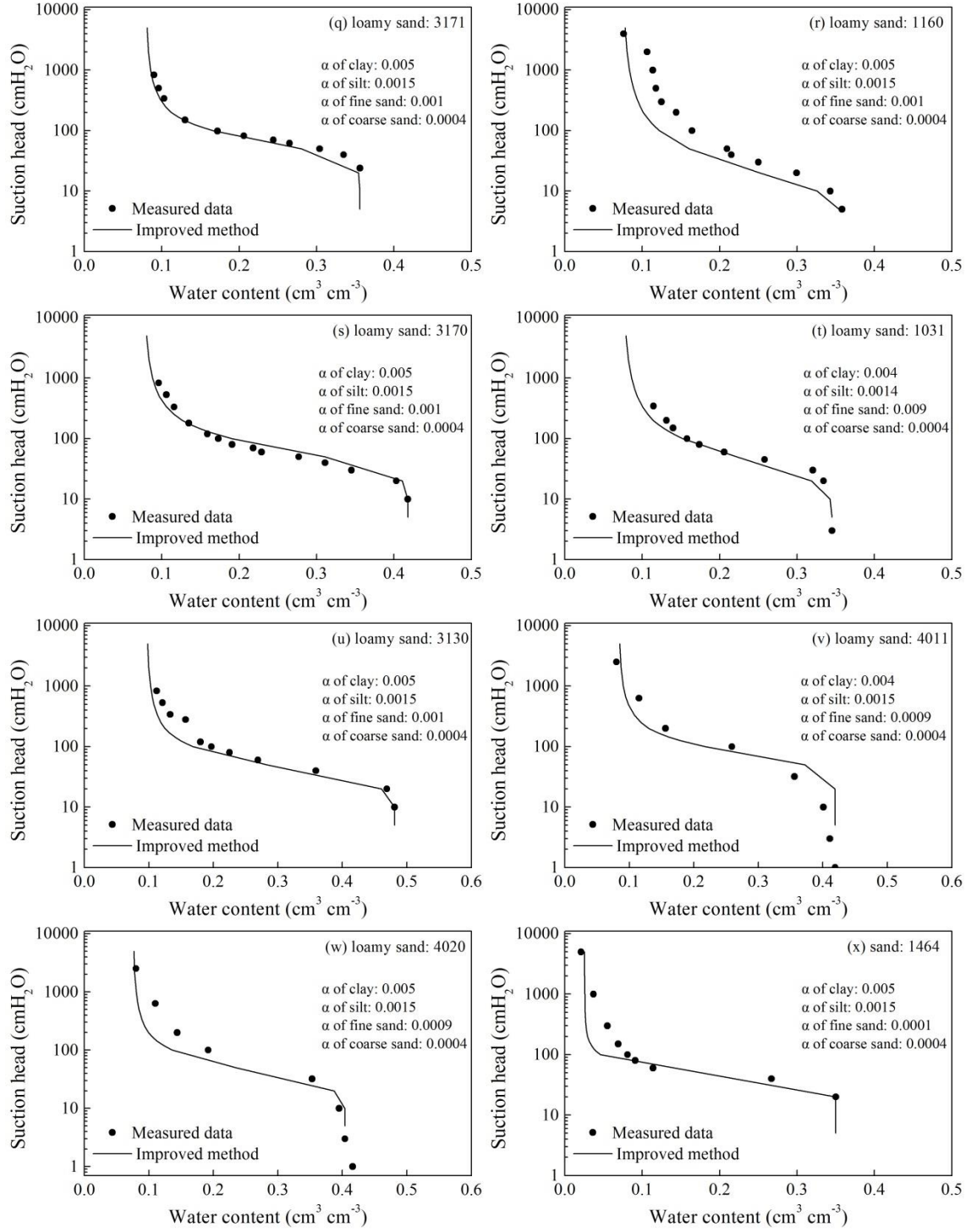


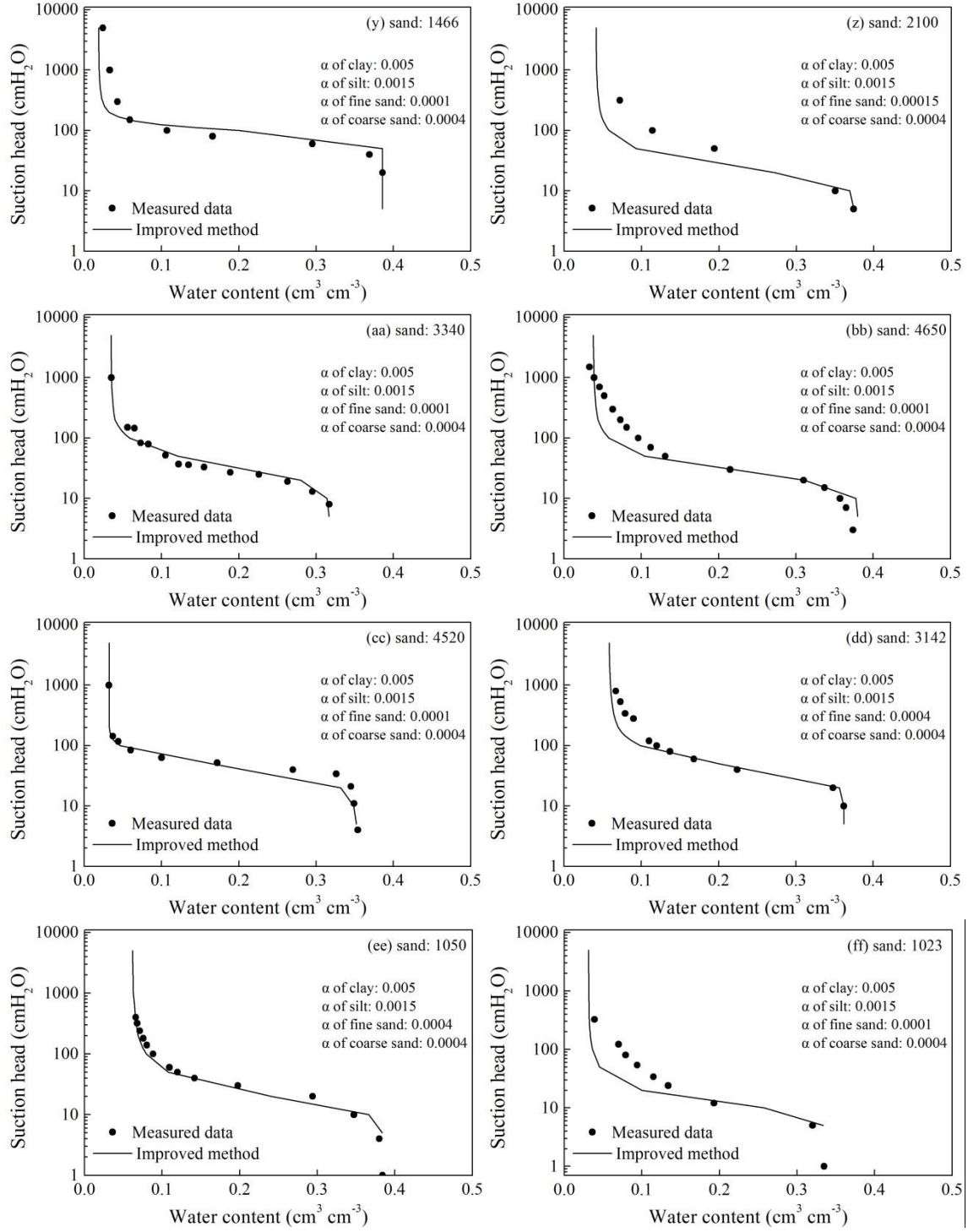
**Figure S1.** Measured vs. calculated pore volume fraction curves and the measured and calculated PoSD curves were embedded in the top of the figures.

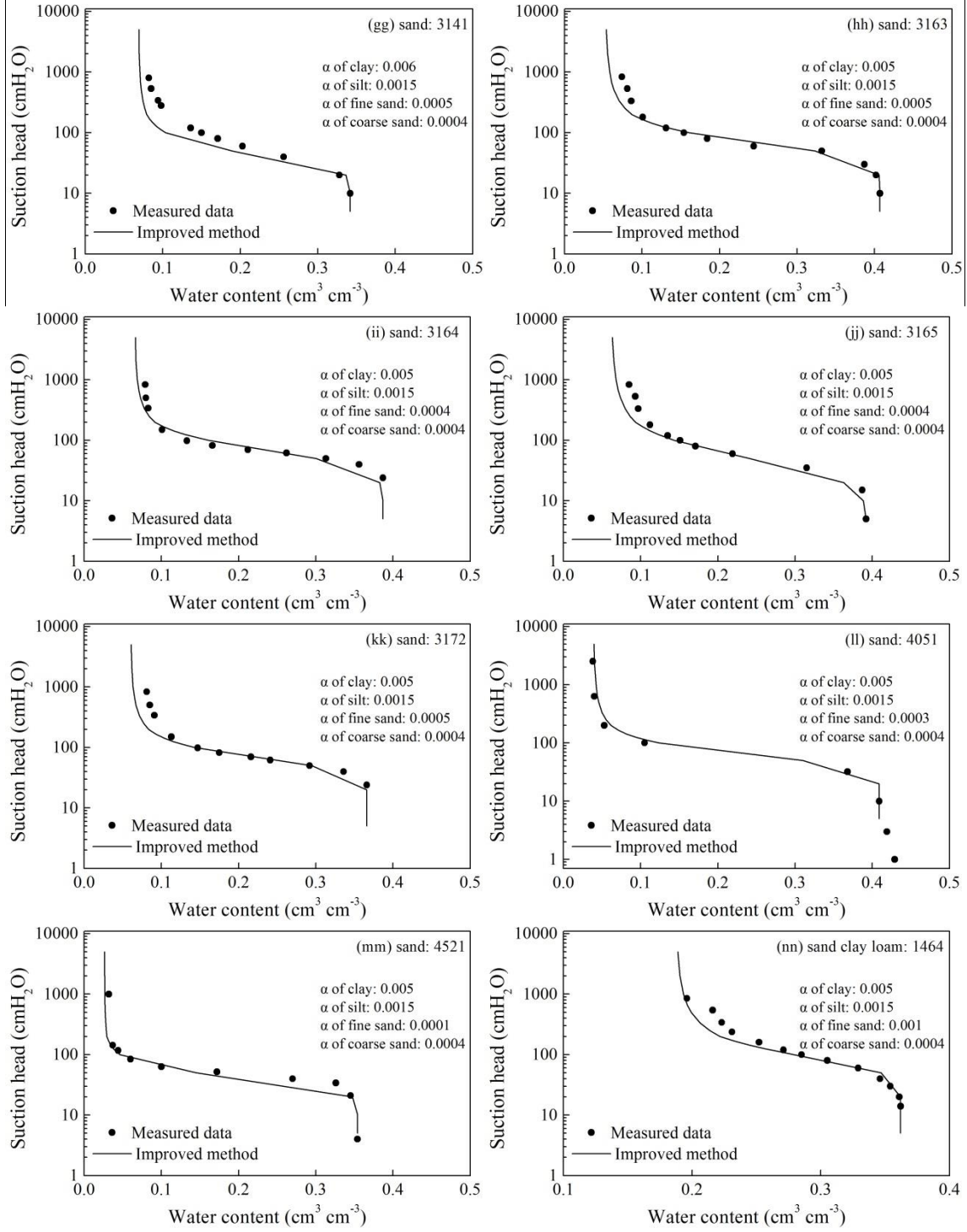












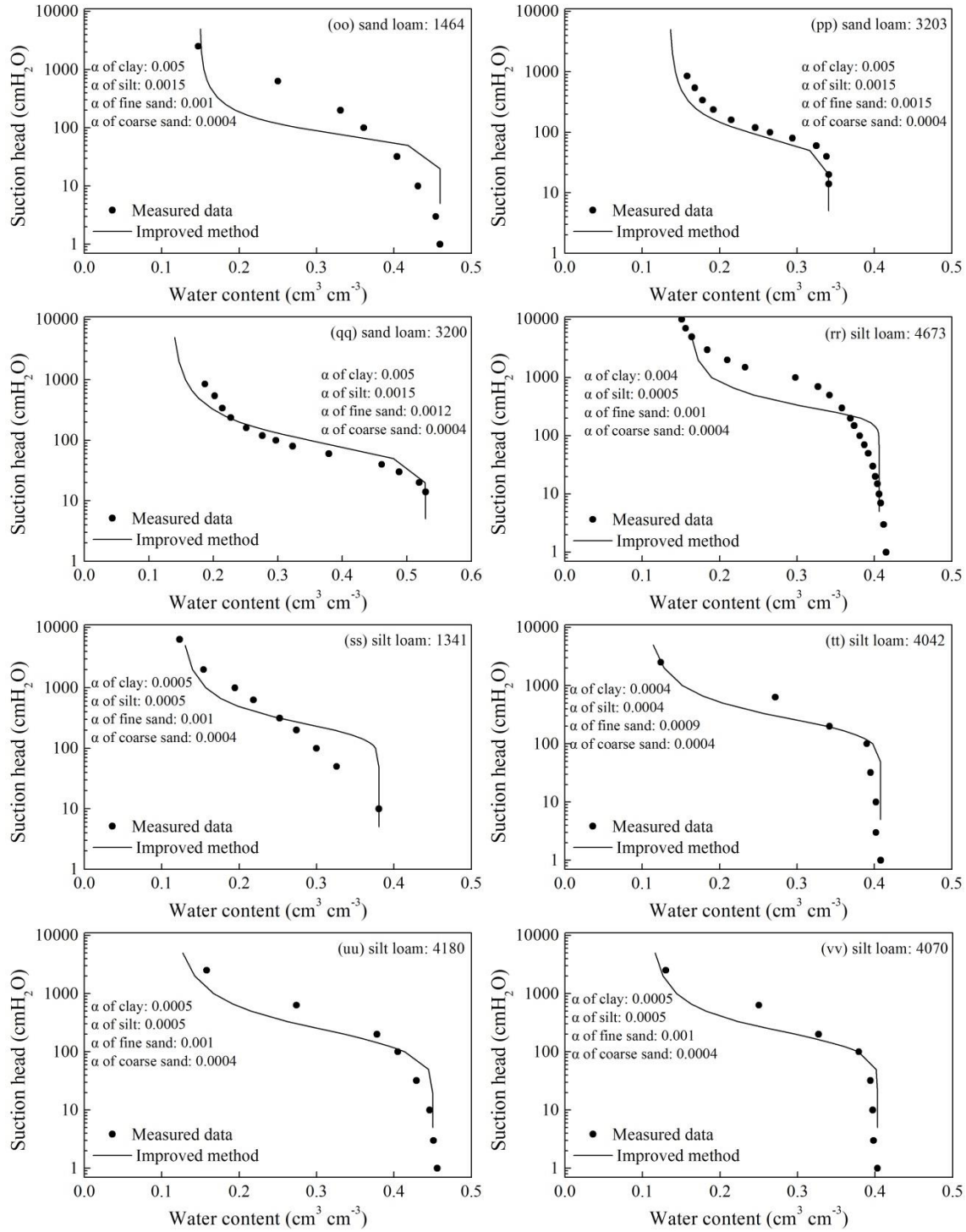
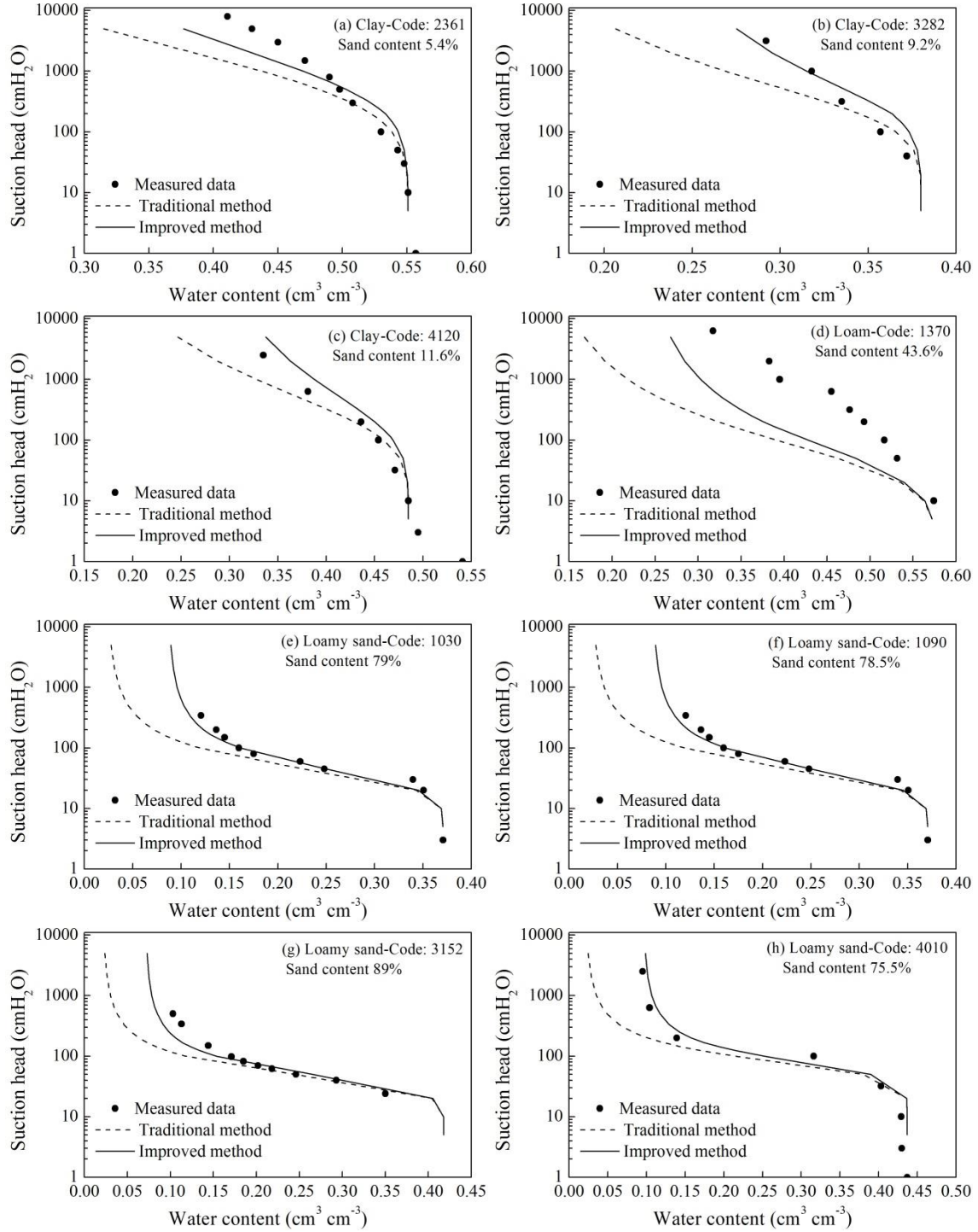
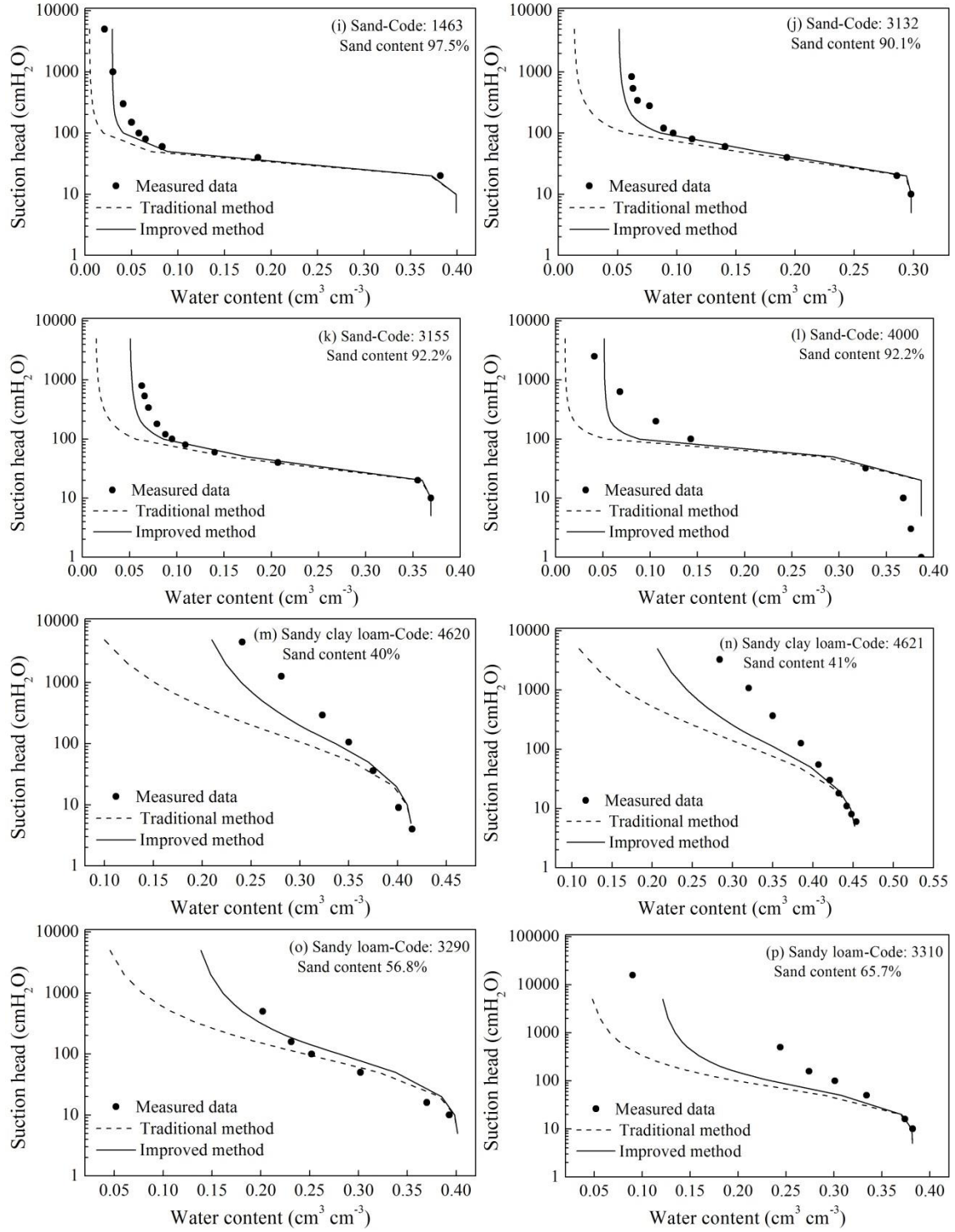
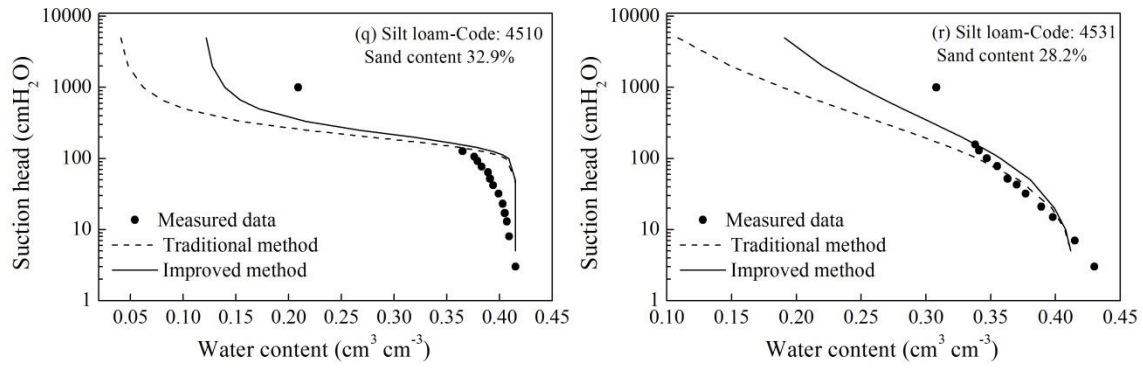


Figure S2. The values of  $\alpha$  when the predicted SWC was in good agreement with the measured SWC.









**Figure S3.** Measured SWC and predicted SWC using traditional method and improved method