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Testing the ISP method with the PARIO device: Accuracy of results and influence of homogenization technique

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The particle-size distribution (PSD) is one of the main properties of soils. To determine the proportions of the fine fractions silt and clay, sedimentation experiments are used. Most common are the Pipette and Hydrometer method. Both need manual sampling at specific times. Both are thus time-demanding and rely on experienced operators. Durner et al. (Durner, W., S.C. Iden, and G. von Unold (2017): The integral suspension pressure method (ISP) for precise particle-size analysis by gravitational sedimentation, *Water Resources Research*, doi:10.1002/2016WR019830) recently developed the integral suspension method (ISP) method, which is implemented in the METER Group device PARIO^{TM}. This new method estimates continuous PSD's from sedimentation experiments by recording the temporal evolution of the suspension pressure at a certain measurement depth in a sedimentation cylinder. It requires no manual interaction after start and thus no specialized training of the lab personnel. The aim of this study was to test the precision and accuracy of new method with a variety of materials, to answer the following research questions: (1) Are the results obtained by PARIO reliable and stable? (2) Are the results affected by the initial mixing technique to homogenize the suspension, or by the presence of sand in the experiment? (3) Are the results identical to the one that are obtained with the Pipette method as reference method?

The experiments were performed with a pure quartz silt material and four real soil materials. PARIO measurements were done repetitively on the same samples in a temperature-controlled lab to characterize the repeatability of the measurements. Subsequently, the samples were investigated by the pipette method to validate the results. We found that the statistical error for silt fraction from replicate and repetitive measurements was in the range of 1% for the quartz material to 3% for soil materials. Since the sand fractions, as in any sedimentation method, must be measured explicitly and are used as fixed parameters in the PARIO evaluation, the error of the clay fraction is determined by error propagation from the sand and silt fraction. Homogenization of the suspension by overhead shaking gave lower reproducibility and smaller silt fractions than vertical stirring. However, it turned out that vertical stirring must be performed with sufficient rigour to obtain a fully homogeneous initial distribution. Analysis of material sieved to < 2000 μm and to < 200 μm gave equal results, i.e., there was no hint towards dragging effects of large particles. Complete removal of the sand fraction, i.e. sieving to < 63 μm lead to less silt, probably due to a loss of fine material by the sieving process. The PSD's obtained with the PARIO corresponded very well with the results of the Pipette method.