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Three-Dimensional Quantification of Pore Space in Flocculated Sediments

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Flocculated sediment structure plays a vital role in determining sediment dynamics within the water column in fresh and saline water bodies. The porosity of flocs contributes to their specific density and therefore their settling characteristics, and can also affect settling characteristics via through-flow. The process of settling and resuspension of flocculated material causes the formation of larger and more complex individual flocs, about which little is known quantitatively of the internal micro-structure and therefore porosity. Hydrological and sedimentological modelling software currently uses estimations of porosity, because it is difficult to capture and analyse flocs. To combat this, we use a novel microscopy method usually performed on biological material to scan the flocs, the output of which can be used to quantify the dimensions and arrangement of pores. This involves capturing flocculated sediment, staining the sample with heavy metal elements to highlight organic content in the Scanning Electron Microscope later, and finally setting the sample in resin.
The overall research aim is to quantitatively characterise the dimensions and distribution of pore space in flocs in three dimensions. In order to gather data, Scanning Electron Microscopy and micro-Computed Tomography have been utilised to produce the necessary images to identify and quantify the pore space. The first objective is to determine the dimensional limits of pores in the structure (i.e. what area do they encapsulate? Are they interconnected or discreet?). This requires a repeatable definition to be established, so that all floc pore spaces can be quantified using the same parameters. The LabSFLOC settling column and dyes will be used as one possible method of determining the outer limits of the discreet pore space. LabSFLOC is a sediment settling column that uses a camera to record the flocs, enabling analysis of settling characteristics. The second objective is to develop a reliable method for quantifying the dimensions of the pores. The dimensions to be quantified are the long- and short-axis lengths, measured using ImageJ. The third objective will be to quantify the distribution of the pore space within the structure, utilising point-to-point measurements and distance from centre of the floc, again utilising software capable of providing accurate measurements between the centres of each pore within the structure.
Preliminary data demonstrating pore dimensional limits and quantification will be presented. This will establish a definition of pore space based on limits of interaction between pore water and the water column, including experimental data from LabSFLOC, and visual representations of pore outer limits. Further to this, I will include some investigational data from ImageJ relating to the dimensions being measured for sub-aim 2. This information is vital in providing accurate and reliable information for hydrological and sedimentological model input, ultimately increasing the value of the outputs.