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3-D analyses on sand grain fabric using X-ray microtomography

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Preferred orientation of grains in sedimentary rocks indicates the flow condition. In the previous studies, 3-D feature of sand-grain fabric has been "estimated" based on the 2-D data obtained from thin-sections. No study has been done on the "true" 3-D grain fabric of sandstones partly because the size of sands is too small for previous methods. In this study, we used a SR X-ray microtomographic system (SP-μCT) at BL20B2 of SPring-8, Japan. The effective pixel size was 5.8 μm and the spatial resolution was twice of the pixel size. The size of the field of vision was 5.8 x 5.9 mm. We made plane beds and current ripples in the laboratory flumes using sand (0.1 – 0.3 mm) consists of mainly quartz and some heavy minerals. Sediments were consolidated with resin and cut out into cylindrical forms of 3.8 mm in diameter. Samples were imaged at X-ray energies 25 keV and 30 keV with 360 projections. The CT images were reconstructed with a program based on the convolution back projection method. After noise reduction, binary images of grains and resin were made based on the frequency of the CT values. We need to identify each grain to get the information of its axes. Thus we newly developed an algorithm consists of the following processes: (1) eroding aggregates of apparently connecting grains, (2) labeling "core" of each grain, and (3) reconstructing domain of grains by dilation. Using this algorithm, we succeeded to identify each grain. Then, each grain was approximate an ellipsoid and the length and orientation of its axes can be calculated. As a result, 3-D distribution of long axes of grains was obtained. It is revealed that X-ray microtomographic system enables us to measure the "true" 3-D grain fabric of sand-sized materials.