Three-dimensional analyses on sand grain fabric using X-ray microtomography : an example of plane bed

Miwa Yokokawa[1]; Hiroki Iwata[1]; Akira Tsuchiyama[2]; Kentaro Uesugi[3]; Tsukasa Nakano[4]; Noritaka Endo[2]; Takahiro Okazawa[2]

[1] Lab. Geoenviron., Fac. Info. Sci., OIT ; [2] Earth and Space Sci., Osaka Univ.; [3] JASRI; [4] Geological Survey of Japan/AIST

Preferred orientation of grains in sedimentary rocks has been known as one of indicators of flow condition. In the previous studies, three-dimensional feature of sand-grain fabric has been 'estimated' based on the data obtained from thin-sections. No study has been done on the 'true' three-dimensional 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 micro-tomographic system in SPring-8 (SP-microCT) at BL20B2. The spatial resolution is about 0.013 mm, which enables us to measure the three-dimensional feature of each sand grain.

The sample used in this study is artificially consolidated sediments deposited in the laboratory flume. We made plane bed using poorly-sorted, medium-grained sand which consists of mainly quartz and some heavy minerals such as magnetite. Deposited sediments were carefully dried and impregnated with resin. From those consolidated sediments, cylindrical samples of 3.8 mm in diameter were cut out. The samples were designed to include lamina, which is a depositional plane where heavy minerals are relatively concentrated. The sample was imaged at X-ray energy 30 keV at SP-microCT. As a result, we got clear images of sand grains.

To get the information of axes of each grain, we have to divide grains which share the contact points. Thus we newly developed an algorithm consists of the following processes: erosion of aggregates of grains, recording the core of each grain, and reconstruction of grains by dilation. Since we succeeded in dividing grains, each grain was approximate an ellipsoid and the dimension and orientation of its axes can be calculated. As a result, three-dimensional distribution of long-axes of grains was obtained. Using this data, we can make two-dimensional data sets on which the apparent long-axes distributions can be measured as same as the previous studies. The result showed the familiar pattern of grain fabric in the previous studies, thus it is proved that the method we used to divide and reconstruct grains is suitable.

The three-dimensional long-axes distribution of plane bed showed that the grains whose long-axes lie almost horizontal are dominant. Although the long-axes parallel to the flow are relatively dominant, the percentage of the long-axes perpendicular to the flow is not small. This suggests a mixture of two patterns of preferred orientation which have been distinguished each other in the previous studies.