Visualization on XCT data of Hayabusa samples: 3D printings and VR

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It is important to carry out mineralogical and petrological descriptions using non-destructive analysis, especially for precious and small samples such as cosmic dust and returned samples from Itokawa. X-ray CT (XCT) has been used widely for these samples to observe three dimensional (3D) structures. In order to survey the 3D data, it is necessary to project them on a two-dimensional screen or create direct 3D models. Recent developments in 3D technology are remarkable, and various visualization technologies are emerging. Here we introduce two kinds of visualization methods: (1) 3D printings and (2) virtual reality (VR) and demonstrate these products applying XCT data of Hayabusa samples obtained in SPring-8 BL47XU [1].

(1) 3D printings: There are several methods for the 3D printings, basically laying out one layer at a time and outputting a 3D model. Matsumoto et al. [2] introduced a method of laying gypsum powder in layers and printing a liquid adhesive from a printer head. Although this method is relatively inexpensive, the structure inside the 3D model cannot be observed since the gypsum is opaque. In this study, we tried a method of repeating the output of ink-like ultraviolet (UV) curable resin and UV irradiations. Some of the ultraviolet curing resins are transparent under visible light, and by outputting together with opaque color inks, 3D internal structures can be observed directly. The surface rendering image (or called isosurfaces) of each mineral can be extracted only by simple binarization processing from the set of slice images using a plugin of ImageJ [3,4]. Object500 Connex performed a 3D printing of Hayabusa sample (RA-QD02-0024) and three inks of cyan, magenta and transparent were used. By assigning a transparent color to the olivine and low-Ca pyroxene widely distributed in the sample, inclusions such as plagioclase and high-Ca pyroxene could be observed.

(2) VR: In recent years, by preparing two screens for stereoscopic vision on smartphones and passing through lenses for stereoscopic viewing, it is possible to easily recognize 3D images. Stereoscopic goggles for smartphones and the dedicated goggle type devices have been available commercially, and these are called VR technology and VR goggles. It is possible to cause the screen to follow the direction in which the observer points the face due to the line of sight sensor. Since it can be introduced easily at this time, we adopted a web VR that allows you to upload VR data to a web server and run it on the web browser of the smartphone. We used A-Frame [5] for the implementation which is one of web frameworks for building VR based on HTML. The isosurfaces created by ImageJ were converted to an appropriate file format using Blender [6] and placed in the VR space. By entering URL for the VR web server on the web browser such as Firefox and waring smartphone VR goggles installed an android smartphone, we could easily access the VR space and observe 3D shape of Hayabusa samples.

It was very efficient to actually perform 3D observation on 3D models and via VR space. At the same time, it is not necessary to install special software for accessing 3D information by using these two methods. This means it is also effective for various analysts to share 3D data of future's samples from sample return missions. In addition, it was also very popular as these were used for exhibitions such as open campuses, so these methods were also effective outreaching.

References

[1] Tsuchiyama A. et al. 2011. Science 333, 1125 [2] Matsumoto T. et al. 2016. GCA 187, 195 [3] Schneider C. et al. 2012. Nature methods 9(7), 671 [4] Doube M. et al. 2010. Bone 47, 1076 [5] https://aframe.io [6] https://www.blender.org