A new tool for microfossil analysis –Microscopic system with automatic image collector collaborated with Artificial Intelligence–

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Although classification of microfossil species originally requires extensive knowledge and experience of exparts, its automating using deep learning which is one of artificial intelligence (AI) techniques enables to obtain reliable results even if experts are absent. In the preliminary experiments of AI-based classification for two radiolarian species (*Cycladophora davisiana* and *Cycladophora sphaeris*), test images were classified with probability of more than 93 % using a classification model constructed by convolutional neural network (CNN) based on 80 images as training data for each species. However, it is hard to manually prepare enough training images for many species. Here, we tried to obtain a large number of images of microfossils (radiolarians) using a device that can automatically obtain microscopic images, and tested to classify them by deep learning method.

In this experiment, we used a microscopic system with an electric XY stage. This system can automatically obtain microscopic images of all individual particles in slides. An imaging flowcytometry analyzer "FlowCam" is also effective for collecting fine microfossil images dispersed in a fluid through the flow cell. Materials used in the experiment are radiolarian rich sediments from the Japan Sea and Antarctic Ocean.

Traning data is divided into categories of *Actinomma boleale*, *Larcopyle buetschlii*, *Cycladophora davisiana*, other radiolarians, disc diatoms, acicular diatoms and clastics from the image obtained by the microscopic system, and constructed a classification model using a deep learning software "RAPID Machine Learning" (NEC). Although the experimental data at the present is still small, the correct classification of *L. buetschlii* with many training data is about 80 %, and for *A. boleale* and *C. davisiana* with less training data, it is about 60 %. In future, it is a task to construct more correct classification model by enhancing training data.

In this experiment, image collection and classification are done separately, however now we are developing a system that can implement deep learning on the device for automatic microscopic image collection. This system, which will be able to obtain a large number of particle images and classify them at the same time, may allow to estimate fossil assemblage automatically. Furthermore, it is expected to be applied in various fields such as medical care and material testing.

Keywords: Micropaleontology, Machine learning, Automatic classification

