3D seismic attenuation profiling for imaging an active fault in Uchiura wan

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We tested seismic attenuation profiling (SAP) to image active faults on a mini-3D seismic reflection dataset observed at Uchiura wan in 2018. Seismic reflection surveys are often conducted to investigate not only geological structures but also development of faults in sedimentary basins, because the past activities of faults are recorded as offsets of geological formations at their locations. However, it is sometimes difficult to specify the existence of faults within highly faulted/fractured areas because seismic reflections are inherently invisible there. SAP has been, therefore, applied to image faults as well as fractures and investigate their activities in poorly reflective areas: the igneous oceanic crust and volcanic areas.

SAP is a method to map seismic attenuation property using seismic reflection data. The authors use the spectral ratio method to estimate Q from seismic reflection data in frequency domain, because the method can be robustly applied in poorly reflective area. Reversely, Q-estimation methods in time domain are not stable in such areas because no reliable amplitude information is available there. However, SAP using the spectral ratio method has not been applied to image faults and fractures developed in sedimentary units (e.g. Tsuru et al, 2017; 2018), because the accuracy in Q-estimation decreases due to spectrum distortions. The spectrum distortions are mostly caused by interruption between primary reflections and interbed multiples within the sedimentary layers. Shimizu (2019) investigated the influences of several Q-estimation methods to interbed multiples by numerical experiments and then improved some processing parameters in the estimation of Q in the frequency domain. As a result, the authors successfully imaged a trend of an active fault on SAP time-slices (Q-slices) from a mini-3D seismic reflection dataset.

A high-resolution mini-3D seismic survey was conducted at Uciura wan in Suruga Bay on August 7th in 2018, by chartering R/V Daini Ikoi Maru of Oki Seatec Co., Ltd. During the survey, twenty of seismic lines were collected with sampling rate of 1 ms. An underwater speaker was adopted as an energy source in consideration of mitigating impact on marine ecosystem. Shot records were collected every 10 s (equivalent to about 10 m with the vessel speed of 2 knots) with a streamer cable of 16 channels. The source and the streamer cable were towed at 0.5 and about 1 m depths, respectively.

As a result of seismic data processing, including band-pass filter, NMO corrections and stacking with one velocity of 1500 m/s, a 3D seismic cube was created. The seismic cube was used for input data of SAP analysis. The data processing was conducted by MATLAB. On the other hand, as a result of the SAP analysis, a 3D cube of average Q was created. An active fault, which cuts seafloor, was clearly demonstrated over several seismic reflection profiles. However, its trend was not clear on seismic time-slices. Reversely, the trend of active fault was clearly figured out on several Q-slices as high attenuation anomalies. In this paper, we would like to show the results of SAP analysis from the mini 3D seismic reflection data observed in Uchiura wan.

Keywords: seismic attenuation, active fault, 3D seismic data

