Bed deformation measured by distributed optical fiber and its sedimentological interpretation: alternated sandstone and mudstone aquifer, Boso Peninsula, Japan

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We have been developing a technology to monitor real-time bed deformation by utilizing the distributed fiber optic sensing. Pumping test results illustrated that uneven bed deformation in an aquifer during pumping groundwater. This uneven bed deformation may be related to geological heterogeneity. For investigating geological heterogeneity, sediment cores were taken from the target aquifer, however detailed sedimentological features are less studied. Purposes of this study are to clarify sedimentary environment and grain size features on the basis of core analysis, and to compare core analysis results with bed deformation signature during the pumping test.

Sediment cores were taken from a Middle Pleistocene alternated sandstone and mudstone aquifer on Boso Peninsula, Japan. Facies analysis indicates that 3 types of sand layers were recognized in the cores: type 1 is single normally graded bed, type 2 is inversely-to-normally graded bed, and type3 is deformed beds in association with rip-up clasts. These features indicate that these sand layers are event deposits. This interpretation supports the view from the previous study that sandstone beds in the target aquifer are interpreted as event deposits in front of a shelf-margin delta. Grain-size analysis of the cores indicates that three depositional cycles were recognized at the depth between 164 and 230 m. Depositional cycles are the origin of the geological heterogeneity in the aquifer, which appears to be related to transgressive-regressive cycles.

Pumping test results showed four intervals with no bed deformation at the depth between 164 and 230 m. These intervals with no bed deformation appear to be related to the geological feature of the aquifer. Comparison between strain measured by optical fiber and depositional cycles identified by detailed core analysis indicates that depths with compressive strain correspond to that composing of coarse-grained sand beds. This pumping test result suggests that compressive strain, which can be used as an indicator of the groundwater pathway in the aquifer, largely depends on the lithology and grain size features. The field experimental results demonstrated that the bed deformation monitoring using distributed fiber optic sensing is useful for as indirect evaluation of the hydraulic properties of aquifer, which is closely linked to geological heterogeneity.

Keywords: Alternated sandstone and mudstone, Optic fiber sensing, Monitoring of bed deformation

