Characterization of the aquifer at Tottori sand dunes using NMR and GPR sounding

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We have conducted the surface NMR and GPR surveys at Arid Land Research Center, Tottori University. The surface NMR is a non-destructive survey for characterizing aquifer using loop on the ground surface which are used for transmitting and receiving coil. The NMR signal is proportional to the magnitude of the magnetic field, so the signal obtained by the surface NMR is much smaller than other NMR method such as NMR logging, because the magnetic moment of the earth is very weak. Therefore, the surface NMR is mostly difficult to apply in the suburb of an urban area. The research center is located at only a few kilometers away from the Tottori city and the EM noise level is not so small. Yet, the noise level is within the acceptable levels by noise tester. A 35 meter side eight-square loop is adopted in our survey, and total 12 pulse moments are used to obtain a full sounding curve. Only less noise data are acquired and more than 250 data are stacked to increase the signal to noise ratio. A typical NMR signal showing exponential decay curve was observed at a certain pulse moment. Full sounding result is compared with the forward modeling and we inferred that a few meters thin aquifer exist at 30 meter depth.
GPR is usually applied for shallow subsurface investigation down to a few meters deep. Especially, the penetration depth will be shallower for the heterogeneous subsurface or clayey soils. However, the penetration depth goes deeper for the homogeneous thick sand deposit such as Tottori sand dunes. We completed the profile and the CMP surveys by 35 MHz antenna. The velocity of the EM wave is calculated from the CMP measurement and we created the depth profile using the calculated EM velocity. A clear reflection boundary is observed at around 29 to 30 m depth in the depth profile. The depth of the reflection agrees with the actual water level measured at several monitoring wells in the survey area.
The surface NMR enables us to obtain one dimensional result of water table and thickness of the aquifer, while GPR provides two dimensional image of water table. Therefore, combining the two methods must be an effective method to characterize aquifer in arid area.

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