Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AHW29-P07 Room:Convention Hall Time:May 23 18:15-19:30

On the underground water flow circulation system in Tottori sand dune based on the geo-electircal method

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The purpose of this study is to clarify and construct the underground water circulation system beneath whole Tottori sand dune symbolized by the generation mechanism of oasis in the sand dune having a high natural cultural value, through the investigation research based on the geoelectrical method.

Tottori sand dune is positioned in the Sanin Kaigan National Park. A good condition of the natural coast can be preserved and the information of a wide variety of natural phenomena such as the interaction of wind and sand and the history of special topography formation has been accumulated since long ago, there. A small spring area called oasis naturally formed in the sand dune is seen as one of valuable natural phenomena in Tottori sand dune. This oasis is positioned right under a big slope called Umanose and plays an important role as a landscape factor forming the natural scenery of Tottori sand dune.

What is the carrier of underground water such as oasis spring? Referring to the Tottori sand dune columnar section shown by Akagi (1991), in Tottori sand dune, a volcanic ash layer, including Daisen-Kurayoshi pumice originating from Diasen volcano, exists above the bedrock as a key bed and the sand dune is separated into two parts by this layer as a border, the upper part of New sand dune and the lower part of old sand dune. In the volcanic ash layer, an impermeable layer that water can hardly penetrate, consisting of clayey volcanic ash soil, clayey loam and clayey soil, and a permeable layer consisting of pumice are found. In this paper, as a candidate, the volcanic ash layer can be assumed as an impermeable layer an aquifer. If the underground water surface were formed by such mechanism, a linear relation between the difference of self potential measured on the two points in the sand dune and the layer thickness from the surface to the underground water level on the two points should be expected from the observation values.

In this study, a Self Potential (SP) measurement was implemented in the whole Tottori sand dune including the oasis spring area and the volcanic ash exposing area to attain the study purpose. The SP measurement result generally shows that the SP in a high altitude area becomes low and that in a low altitude area becomes high. As mentioned above, it is known that such a relation is found when an electrokinetic phenomenon (streaming potential) caused by underground water flow with undulations of topography is observed. In the sand dune, the same measurement result was obtained. Examined the relation between SP (mV) and altitude (m), a clear correlation having a streaming potential coefficient that appears to be -3mV/m was found. However, it was found there was a big difference in the coefficient between around the volcanic ash exposing area, especially the area where volcanic ash is expected to exist beneath, and the area where it is not expected.

Assuming the predicted result mentioned above could be effective, the underground water level in the sand dune area was estimated by using the SP measurement result. The equation (14) of Zlotnicki and Nishida(2003) was used as the one to find the underground water level. In the sand dune area, as a few academic borings have been done so far, the validity of the estimated result in this study was examined by using the data in the past borings. Examined and compared the results about the four points near the measurement points where the borings were done, the both was found to almost accord. We would like to discuss about the effectiveness of the SP method applied to the underground water distribution investigation under Tottori sand dine by comparing with the resistivity structure obtained from other methods such as an electrical investigation, hereafter.

Keywords: Tottori sand dune, underground water, geoelectrical method