SUBSURFACE MICROWAVE REMOTE SENSING AND SCATTERING MODELLING ON HYPER-SALINE SOIL: EXAMPLE OF LOP NUR

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ABSTRACT

Subsurface microwave remote sensing is a direction of Synthetic Aperture Radar (SAR) research. With the penetration capability SAR is capable of detecting the subsurface targets and materials, especially in arid environment. Lop Nur Lake is located at the east of Tarim Basin in Xinjiang province of China. Since it is a catchment basin of major rivers running in Tarim, Lop Nur Lake has highly concentrated mineral materials, especially potassium sediments. Lop Nur Lake is described as "dry core" of the world and it can provide conditions for SAR penetration. Furthermore, lacustrine deposit under the surface with high water content and salinity is universally existed with extremely dry layer over. And Lop Nur shows us a perfect "Ear" pattern on SAR images. Based on past research and analysis, we guess that the subsurface layer with high moisture and salinity is the fundamental reason to Lop Nur strong microwave backscattering, and surface roughness conditions form the "Ear" texture.

Based on field investigation in 2006, we conducted several experiment researches and analysis. At first step, we conclude the structure under the surface in Lop Nur as two layers. One is dry materials on top and the other is the certain layer with high moisture and salinity at the bottom. We consider the transmission, attenuation and surface backscattering effects, and ignore possible volumetric scattering during signals propagate through the top layer. Then we develop a two-layer backscattering model. In order to test the model, we conduct the second field investigation in 2008, and we use Ground Penetration Radar (GPR) as an auxiliary means for the first time. At the meanwhile, we improve surface roughness measurement to get more accurate results. Using measured data, we can test the two-layer model compared to ALOS PALSAR (L-band) and RADARSAT-2 (C-band) calibrated images. The results show that simulated results are more close to L-band images because two-layer structure is more appropriate for L-band.

During field investigation in 2006, we collected 40 subsurface samples and 30 surface samples. Meanwhile, surface roughness conditions were also collected by using digital photogrammetric technology. In laboratory we measured their moisture, salinity and complex dielectric constants. In 2008, we collected 400 soil samples according to "Ear" texture, in order to correspondence analysis with SAR images. This paper figures out the physical and chemical measured data analysis, and builds relationship between SAR observations and Lop Nur development. We also conduct multi-polarization analysis.

In order to generate a logical inversion procedure, we consider Genetic Algorithm (GA) which can give out optimum relation of multi-parameter problem. Using GA we can get targets' parameters, and based on measured data we can test the algorithm precision. Note that GA can help give the optimal results within certain range, but the inversion results are a little different from laboratory measured data. This is because the two-layer structure is an abstract concept, and true scattering mechanisms are more complex. However, at certain sample sites, we still have good consistency.

Under the support of SOAR Program sponsored by Canadian Space Agency, we can get RADARSAT-2 full-polarimetric data. In near future, we will focus on full-polarimetric technology research, and based on polarimetric decomposition and polarimetric synthesis the more information about shallow targets at subsurface is anticipated.