APPLICATIONS OF POLARIMETRIC DECOMPOSITION TECHNOLOGY IN A DRIED UP LAKE EVOLUTION

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1. INTRODUCTION

Lop Nur is located at the east Tarim Basin in Xinjiang Autonomous Region of China. As it is a catchment basin of major rivers running in Tarim, Lop Nur is rich in mineral materials, especially potassium sediments. Lop Nur is described as "dry core" of the world, and there are a lot of salts at surface and subsurface with low and high moisture respectively. With the penetration capability for SAR (Synthetic Aperture Radar) signals and arid environment for Lop Nur, it is believed that SAR can detect subsurface materials. Lop Nur is famous for "Ear" feature on SAR images (Fig. 1), and its formation is always a mystery. There are some assumptions over the issue, but yet to be proved by scientific evidences. There needs more further analysis on Lop Nur phenomenon.

In 2006 and 2008, two field investigations were conducted respectively. During latest investigation, four profiles through "Ear" region are chosen, and about 400 more soil samples were collected. At the meanwhile, measurements including surface roughness and spectroscopic data were carried out in the field. In laboratory, complex dielectric constants, mechanism compositions, volumetric moisture and salinity were also obtained. Based on the data, some primary explanations about Lop Nur evolution are shown. In view of previous works on scattering model in Lop Nur, it is found that surface roughness condition is the immediate cause of "Ear" feature on SAR images. However, many evidences reveal that certain subsurface property is the fundamental cause. To exactly explain Lop Nur phenomenon, a appropriate analyzed method is needed, and a summary of the evolution laws about Lop Nur is necessary.

SAR polarimetry is the science of acquiring, processing and analyzing the polarization states of an electromagnetic field. Radar polarimetry is concerned with the utilization of polarimetry in radar applications. In the past, several scientists devoted to develop classic polarimetric algorithms and put forward some parameters which can describe targets characteristics. Polarimetric decomposition can provide relative simple contributions based on scattering mechanisms. And it is shown that multiple or volume contribution can describe "Ear" exactly (Fig. 2). The objective of this paper is to explore fundamental influence factors of multiple or volume contribution, and further to figure out its meanings about Lop Nur evolution.

2. POLARIMETRIC DECOMPOSITION TECHNOLOGY

2.1. Methodology

Scattering decompositions are widely applied for interpretation, classification, and segmentation of polarimetric data [1]. They have also been applied for scattering parameter inversion. In the following, Cloude decomposition and Freeman-Durden decomposition are mainly used in this paper [2, 3], which are based on eigenvectors and scattering models, respectively. Detailed analysis of scattering mechanisms in Lop Nur will help to understand polarimetric decomposition results, and it is anticipated that fundamental cause of "Ear" feature will be obtained.

Both Cloude decomposition and Freeman-Durden decomposition can give out three scattering components, which are surface, dihedral and multiple or volume scattering contributions. However, there are some important differences between the two decompositions. The first one deals with the statistical independence of the obtained components, which are orthogonal to each other, and the scattering components of the model-based decomposition are not independent [4]. In this paper, multiple

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or volume scattering component is the interest. Through exploring its main influence factors, more information about Lop Nur evolution, especially the reason to formation of "Ear" feature, will be gathered.

2.2. Applications in Lop Nur evolution

After extracting multiple or volume scattering components, based on the two compositions above, comparisons between volume contribution and subsurface parameters from field investigation are carried out. Fig. 3 shows comparison between multiple or volume scattering component (HV polarization) from Cloude decomposition and subsurface salinity. It is believed that consistent changing rule at certain region can be obtained. And at the edge and centre regions of Lop Nur, inverse proportional laws indicate that Lop Nur is not drying up all the while, and it can not be explained following a simple evolution law. Likewise, Freeman-Durden decomposition also show the similar results.

In view of statements above, it is figured out that subsurface salinity is the fundamental cause of "Ear" feature on SAR image. In the previous paper, surface roughness condition is viewed as immediate cause [5]. And dynamic mechanism of geomorphology can unify these two causes to a certain extent. More subsurface salinity can produce salt heaving effect more intensely, and with long-term eolian erosion and evaporation, extremely rough surface condition is eventually created. If the certain subsurface properties can be found, it is helpful to conduct comprehensive studies on Lop Nur phenomenon. And other aspects such as salt lake evolvement, paleoclimate and geological movement may give impetus to the further research.

3. CENTRAL CONCLUSIONS

Lop Nur is a famous dried lake, and its evolution always encourages attentions from scientists of various aspects. The formation of "Ear" feature is always a mystery over the issue. This paper provides a fundamental cause using polarimetric technology. And the conclusions conform with our researches about scattering model and dielectric model. With more and more polarimetric SAR launched, polarimetry will be used widely. And this paper shows the applications of polarimetry in arid region environment. In next works, further detailed scattering components are anticipated, and quantitative relationships between polarimetric parameters and measured quantities can be built exactly.

4. REFERENCES

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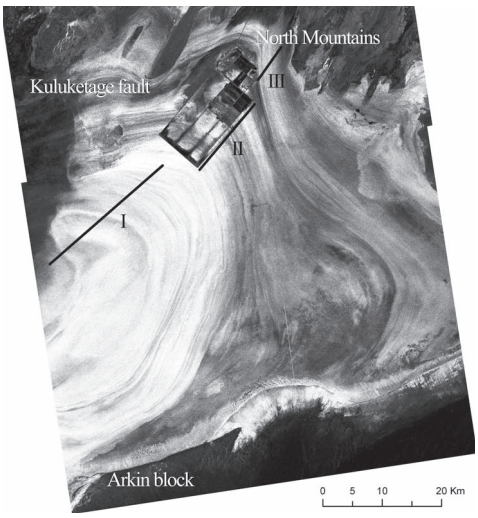

Fig. 1. ALOS PALSAR (L-band, HH polarization, 34.3 ° incidence angle) image for Lop Nur on August 23, 2007, with clearer "Ear" feature and geological structure conditions marked. Central region is brighter than edge region. I, II and III represent three investigation routes from centre to edge in Lop Nur in 2006.

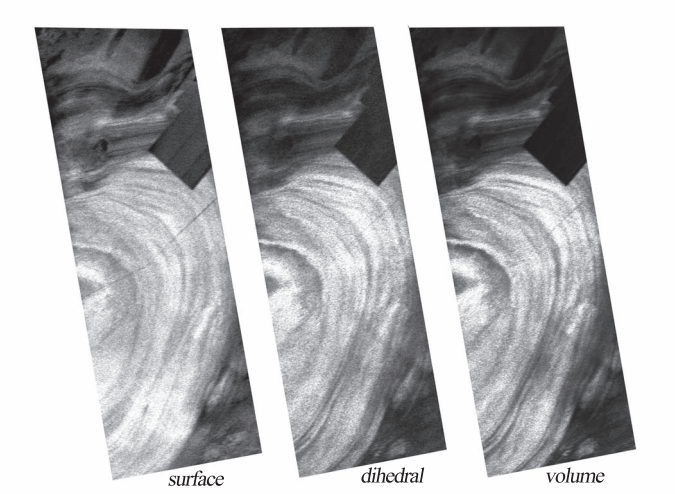

Fig. 2. Cloude decomposition results based on PALSAR images on May 6, 2009, which are surface, dihedral and volume scattering contributions, respectively. All the images have finished precise geometry rectification.

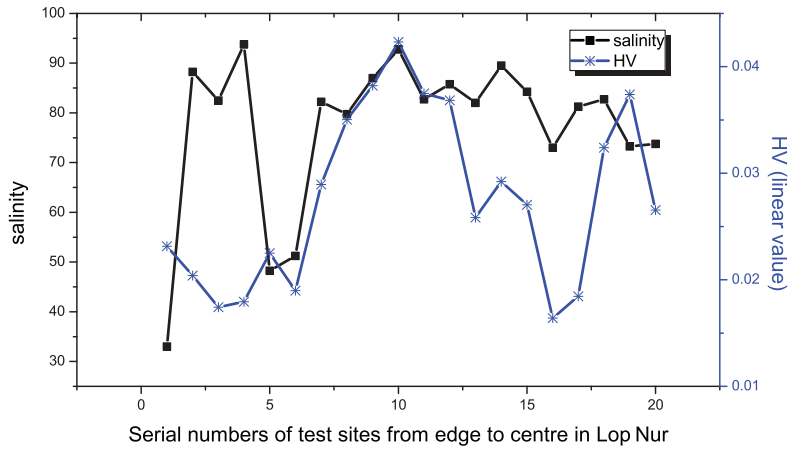

Fig. 3. Comparison between multiple or volume scattering component (HV polarization) from Cloude decomposition and subsurface salinity, where HV coefficient and salinity are in linear and percentage scales, respectively.