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The Application of SLAR Image in Surveying Fossil River Course

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Abstract: Keliya River is in hinterland of the Taklamakan desert and forms a mystic green corridor. Revealing the distribution feature of the lower reaches fossil river has important significance for its ecology construction and groundwater source surveying. Using X-band SLAR image as an important information sources, and combing with the field investigation, the fundamental principle and imagery feature of the river course of airborne SLAR image are studied and analyzed in this paper, the paper also analyses the characteristic and its changes process. By sampling data and sampling mathematical model, approach the pass through effect of the SLAR image. The study indicated that the X-band of the SLAR image could pass though 14.6cm depth in the region of background desert, and 10.34cm depth in the fossil riverbed.

1 Preface

Keliya River is one of the longest rivers that are through the Taklamakan desert. It enters into desert in Yutian county, cutouts after entering in Misalai and becomes a seasonal river. The lower stretch of river takes seasonal supply of excessive water below. Along the sides of river are bushy Huyang and Hongliu trees, which brings about a strip of green corridor. Especially Daliyaboyi oasis is seldom seen in the world, which is 324 km^2 and insets in the hinterland of extensive desert. To research on channel distribution and change of Keliya river into Daliyaboyi oasis can provide basic data for searching shallow fountainhead in desert hinterland and also provide important rely on protecting the mystic green corridor and ecology construction and selection on exploration tour route in the desert. This paper deals with the distribution and change of lower stretch of the Keliya river and analyses the basic cause of channel image and proceeds the study of penetrating of Radar and gives examples of application of SLAR images.

2 Basic channel characters

Keliya river enters the depths of desert, whose character gives regional disparity with water volume and forms sorts of regular geomorphic scene.

2.1 Modern channel

Modern channel is the channel that is still receiving release excessive water from upper stream .Its appearance traits is visible. In Daliyaboyi district, it becomes many Channels extended. For the number and volume of replenishment of the release excessive water is so many, the surface layer of channel is hoary mud-alluvial, below it is fine sand bed. Terraces of two sides of the riverbed, on which are Huyang and Hongliu, are basically symmetry. Isolated multiplex sand dune spread over among channels. With the extension of course of river, the number and volume of supplying decrease gradually, channel gradually becomes sand-rich and form rudiment crescent dune and ridge. Along the bank is sand pack formed by Huyang and" activation "Hongliu. Withered Huyang increases gradually and disappears into desert with course of river disappears.

2.2 Fossil river course

Fossil river course is the river that did not receive release excessive water for a long time and was abandoned due to river channel change. Because of sandstorm, the sand of riverbed was blown and formed densely crescent sand dune and sand dunes chain. Its height is 1~ 3 m. The appearance of channel was not clear enough, but still remnant Huyang and Hongliu are strip-like. Its periphery was a quite tall and big dike composed of compound ridges, which is quite different from view of modern channel. The lower the stretch of river is, the stronger the wind blows. Spiccato lamella hoary dusty sediments represented riverbeds are seen among bushy and low movable dunes. Along the bank are remnant Huyang and wafted brushy sand pile. Whole view is a north-north east narrow belt embellished in the vast sand sea.

As you can see, Keliya river in deep desert is closely interrelated with the distribution of Huyang, no matter modern river or fossil river, Huyang are distributed along all lateral sides. So we can say that belted Huyang are indications of channels, which is a trait of Keliya river in deep desert.

3 Channel image traits analyses

Radar image records the echo information that objective scatters back. The depth of hue of the image explains the degree to which object scatters back. When Radar parameters designed are sure, the key factors that determine the gray degree are back scattering coefficients. There are many elements that influence scattering coefficients s °. s ° is the function of the parameters as follows:

$$s^{\circ}=f(\ ?,\ ?,\ P,\ F,\ e,\ t_1,\ t_2,\ V)$$

Among them, the parameters that relate with Radar system are: wavelength *?*, an angle of incidence *?*, polarization *P* ; the parameters that relate with object are azimuth *F* , complex dielectric constant *e*, surface coarseness degree t_1 , sub-surface coarseness degree t_2 (when electromagnetic can penetrate the surface) ,un-homogeneous body scattering coefficients *V*?

The sediment of the earth in our workaround is sandy sediment, we can regard that the medium is even, and we need not consider its body scattering. So at the given Radar system parameters premise, s° is related with surface coarseness degree and complex dielectric constant. Surface coarseness degree directly influence space distribution of electromagnetic wave scattered from the object measured and change echo energy. And complex dielectric constant affects the power of object reflecting electromagnetic wave and penetrating to object.

According to different echo capabilities of Radar to object, we can divide the coarseness of object into three classes, that is: smooth surface, medium coarse surface and coarse surface. Smooth surface can send out mirror reflection to Radar microwave, nearly all energy is reflected out and no echo signal. So the tone of smooth object on Radar image is quite dark. Coarse surface will produce diffuse reflection to Radar microwave. Therefore, quite large of energy return back to Radar, that form stronger echo signal, so the Radar image of object of coarse surface submits light tone. The reflection of the medium coarse surface to radar echo wave are mix, some of the energy are back to Radar, which forms medium echo signal that show middling gray tone. The rules of determining the type of coarse surface are Peake and Oliver rule. That is: when *h* is less than *?*/25sin*b*, the surface is coarse one, when *h* is more than or equal to *?*/25sin*b* and *h* is less than or equal to *?*/4.4sin*b*, the surface is medium coarse. In the criterion, *h* is relief root-mean-square of object surface rise and fall, *b* is radar antenna depression angle , *?* is radar wavelength?

Hereby, using the SLAR parameters, we can work out the limit value of the *h* in research area:

Smooth surface: $h < 0.35$cm;

Medium coarse surface: $0.35\text{cm} = h = 2.00$cm;

Coarse surface: $h > 2.00$cm.

Based on the criterion above and after analyzing the granularity of the channel and dune sand, we find that the granule radii of channel and dune sand are all less than 0.30cm, which demonstrate that the surface of the channel and dune are smooth surfaces so they are dark tone in the SLA image.

Vegetation bed is the dimension composed of many scattered elements. Its top is by air limit, and the bottom is limited on the soil surface. In commonly instant, scattering coefficient behind is determined by the system scattering of elements such as vegetation and soil surface and many scattering functions between vegetation and soil surface. The vegetation beds of the sides of modern channels bear numerous branches and luxuriant leaves and contain great water. Leaves in the dimension that can be regarded as isotropy scattering elements are the main part. Dispersion waves in the dimension are in every direction. So Radar can receive strong echo and submit terribly bright tone. The contribution of the vegetation beds on the channel sides that is sear and sparse weak a lot. The mirror reflection generated by uncovered soil beds is dark tone. With all the integration above, reflection is a little dull as a whole.

4 Characters of channel changes and its cause

SLAR image and data from the exploration clearly show that the distribution of Keliya river in the depths of the desert. The water course of the lower stretch of Keliya river separate into east and west branches near Dliyabu, which succeed new and old deltas of different sights.

The west branch is a fossil river that becomes an old delta. Near Daliyabu, Keliya river extends to north composed of several wide river courses, and near 93km of the south of Daliyabu, it expands a disperse water system, whose density is as large as 0.7~1 per km. When it keeps on north, most of the channel courses disappear, and in 30km distance of Talim river, the last channel course disappears. On old delta, we can see dense crescent dune chains and inter phase of clusters and sand piles. Only spasmodical channel bed remnants oriented north-north-east and spasmodical band withered Huyang can shine outline of the old water cycle.

East branch is a modern channel, which receives seasonal flooding water and forms a new delta. Channel course disperses near Daliyabuyi and extends to NNE. The density of water system is quite large, about 0.5-0.7 per km. In distance of 70km of Daliyabuyi, it converges three big and wide channel courses to go ahead to north. One of the three is intersected with fossil channel and finally disappears in the desert. On new delta, affected by intermittence flooding, savageness green vegetations centered in riverbeds make up of the basic character of the new delta. Among savage oases are many isolated compound dunes, which are 25~ 50 m high and characteristically like isolated islands in the green ocean.

The views of the two channels above are obviously different, which is affected by channel course vicissitude and sand blowing. According to ancient data, Keshidun site situated on fossil channel terra of western old delta spasmodically distributes along SN direction, and is 5~ 6 m long. The result of analyzing Huyang ^{14}C from Keladun house building material shows that dweller equal to Westhan time was in existence. Unearthed cultural relics as copper cash? potsherd and fresco Show that the existence of the dwellers went down to early 7th century. During that period, that was not desert view but the oasis of the low stretch of Keliya river. During A.D. 8th century, it became desert quite badly. The relics from the area found after A.D century show that. So channel course changed probably during A.D. century. The main reason for changing course is Keliya river took a lot of sands and filled up in the low stretch of the river and riverbed run-up gradually, finally it clashed the bank and the river course changed. The result of changing course was that water source was broken off, plants were destroyed and savage vegetation gradually lost its defense. After wind blew, flowing dune invade forward. Dry riverbed piled sand on the spot, which brought up the view of flowing dune, clusters sand pile and spasmodical riverbed living simultaneously. River changing course tended to east that was lower topography. But east part was complex dune chain section. It was river's changing course that for a long time overflowing erosion of flooding incised the lower section of the complex

dun chain, and formed some isolated complex dunes. But in flooding overflowing part, along bank living Huyang and cluster Hongliu,which engendered the view of oasis today. It is like a resplendent pearl setting in the sea of sands and people in the world fix eyes on it.

The prosperity and wane of oasis in the dry section is affected mostly by water. The economy in middle of Keliya river expanded already during tang era, the increasing in using water in the middle stretch resulted the decreasing in the low stretch. After the western oasis abandoned, the development of economy in the region centralized in the middle stretch of the river where there was good water resource, So the new-formed eastern delta region in the lowest stretch of Keliya river never have town and agri-oasis. Plus wind blow and dune closed forward, the traffic in the region was inconvenient. People contacted external world quite difficultly, so the eastern new delta keeps the original natural view of the lower stretch of the river in the depths of the desert.

5 The discussion of the function of the penetrating of Radar

Some of the electromagnetic waves that incident to the smooth surface of radar are reflected back, some are ripped into medium. If the coarse base level under the earth surface disperses, radar can receive its echo information and detect the entity of the object.

Assume that a plain incidence wave is incident from air to medium, If the transmission power on the point just below subsurface ($Z=0^+$) is $P(0^+)$, so the power in the depth of Z is:

$$P(Z) = P(0^+)\ \mathrm{EXP}[-\int_0^z k_e(z)d(z)]$$

In the formula: $Ke(Z)$ is the attenuation coefficient of the medium power in the depth of Z.

The definition of penetrating depth d_p is the depth point of that power attenuated to 1/e., That is:

$$P(d_p)/P(0+)=1/e \quad \text{or} \quad \int_o^{d_p} k_e(z)d(z)=1 \qquad (1)$$

The energy loss of incidence may be absorption and dispersion or both, absorption and dispersion are linearity, that is: $Ke \equiv Ka+Ks$, Ka and Ks are Absorption and dispersion coefficients respectively.

Assuming that we can ignore dispersion in the medium, so $Ke \cong Ka$. Power absorption coefficient Ka is twice times as attenuation coefficient a, that is: $Ka=2a$. If $a(Z)$ is not the function of Z, but a constant, so (1) can be predigested to be:

$$d_p=1/2a \qquad (2)$$

In the formula:

$$a=2\pi/l_0\{me_r'/2[(1+(e_r''/e_r')^2)^{1/2}-1]\}^{1/2} \qquad (3)$$

here, l_0 is free space wavelength, e_r'? e_r'' are complex dielectric constant real part and imaginary part, m is relatively conducting susceptibility. In microwave waveband, non-iron relatively conducting susceptibility is close to 1, that is: $m \cong 1$?

During the exploration, we took sample of sand of slop of dune and riverbed, after testing, we conclude that in the depth of 0~ 50cm, in the slop of the dune, e_r' is equal to 2.69, ε_r'' is equal to 0.050. According to (2) and (3) to calculate that the penetrating depth is 14.56cm. So in the depth of 0~ 50cm of fossil riverbed, ε_r' is equal to 2.66, $\varepsilon_r''$is equal to 0.079.Then its penetrating depth is 10.34cm?

6 Conclusion

SLAR image (X band) plays an important role in explore the distribution of river in the depths of desert. The research shows that Keliya river course in depth of desert tie in with the distribution of Huyang, belt Huyang demonstrates the existence of river course. The lower stretch of Keliya river course separates into east and west parts, which form new and old delta in different views. The density of water system of Old delta is

larger than the new's, about 0.7~1per km. The density of water system of the new delta is 0.5~0.7per km.

SLAR takes on some penetrating capability. In the depths of Takelamagan desert, by sample we tested and calculated that the penetrating depth of SLAR is very low. That in dune region is 14.56cm. and in riverbed is only 10.34cm. All of these show that exploring imbedding objects by X band SLAR is not in significance.

Keliya river is in the depths of deserts and forms a magic green corridor, so people in the world fix eyes on it. By now because of decrease in water and man-made cause, the proportion of oasis decrease gradually, and the environment degenerate continually. So we should adopt avail protection methods to preserve oasis and enlarge it in order to bring it into play in research and exploration tour.

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