High Resolution Remote Sensing Research of Climatic Change of Luobupo Saline During Past 2000 Years

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Abstract: According to the evolutive theory of saline, combined with field survey data, the authors have discussed the theoretical model of recording past climatic change of Luobupo saline. After interpreted and analyzed the causes of the ringy image, the authors have mapped high resolution climatic changing graph of Luobupo saline during past 2000 years by using remote sensing method. Contrast to the known results, it is proved that the research results have comparability and continuity. The resolution of special climatic event can reach in one year, and in general, the resolution of climatic change can reach in ten to twenty years.

Key words: Luobupo saline, ringy image, the climatic change, remote sensing research

1. Environments and interpretation subareas

Luobupo saline locates in the eastern of Tarim basin. The northern of saline is Kulutage mountain, the eastern is Beishan, the southern is Kumutage desert, and western is Kuluke desert. There are Ruoqiang river, Washixia river, Milan river, Cheerchen river, Tarim river, Kongque river, and Shule river in Luobupo water system, in which Tarim river, Kongque River, and Cheerchen river are the main rivers flowing into lake, which provided main sediments to saline. Cheerchen river and Kongque river flow into saline from southwest and northwest, respectively, they were water-breaking after 1962, and were water-breaking and drying-up completely after 1972, which leave the dry riverbeds and river valleys.

The remote sensing image shows a typical scene of the saline from shrinking, drying-up to dying out, on which the ringy image is distinct like the ear (see the fig.1).

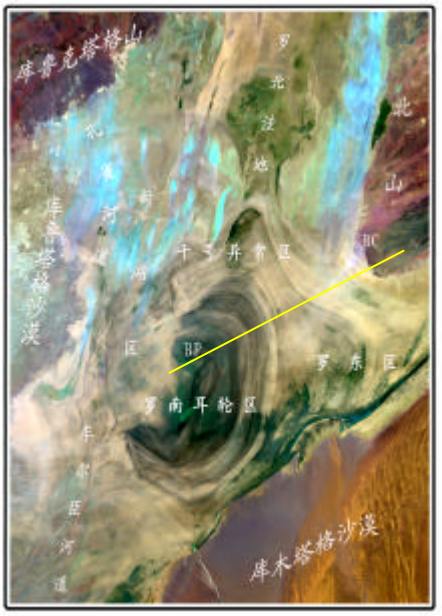

Fig.1 TM image and the division of remote sensing image interpretation in Luobupo region

2. The interpretation of zonal causes and the characteristics of sediments

According to salt-forming theory of modern saline, the forming factors of ringy image are that zones of alternating light and shade reflected the cycle of mud and salt sediments, and recorded the evolutive history of saline. Modern saline underwent five stages which were freshwater, brackish water, salt water, dry saline, and salt-forming in the salt-forming process. In these continuous evolvements, lake area incessant shrunk, and briny concentration increased. The rock salt crystaled and deposited when the concentration of salt reached saturated point. The rock salt deposited in the center of lake when there are no supply of freshwater into lake, the salt concentration of the water near bank is a gradient belt from outfall to far from outfall when there are supply of freshwater into lake. The salt concentration of water is the highest near the bank of far from outfall, the lake water is back water after the deposition of rock salt, and formed the salt deposit belt paralleled the bank, i.e. salt lake[1][2]. Cheerchen river is in the south of Luobupo area, and Kongque river is in the north of Luobupo, which flow from west into saline. Cheerchen river has a great effect on helix area by analysis of the characters of image. Drought is the dominant climate in Luobupo region. The pollen assemblage of drilling indicated that Luobupo saline is the driest region in China, the pollen composition is composed of Artemisa and Ephedra, the proportion of drought-enduring Artemisia pollen was increasing, and at the same time, the proportion of Ephedra pollen was decreasing after late Holocene, it indicated that the climate was becoming dry and dry after Holocene in this region. So we only consider dry-cold and xerothermic climate to simplify the problem, xerothermic climate would shrink and vaporize the lake water, and hence the salt would deposit. However, because Cheerchen and Kongque rivers belong to jokul water system, the increased air temperature would lead to melting of jokul and falling back of snow line, and cause flooding to form seasonality onrush carrying abundant mud and sand into lake. The mud-salt ratio of saline sediments increased in this period, which formed the dark zone on image. The dry-cold climate would drop the air temperature, the rivers would be reduced the water quantity or be covered with ice, thus, there was no supply water into lake, and the salt has deposited near the bank far from the outfall. At the same time, because of temperature reducing, the solubility of salt has been reduced, and the salt would separate out, the mud-sand ratio of saline sediments decreased in this period, sediments would form the pure salt deposit zone which parallel to the bank, i.e. tint zone on the image.

3 The principle of remote sensing method and physical model

The high-resolution remote sensing study of about past 2000 years climatic changes is based on pick-up surface sedimentary composition variational information of the saline by using remote sensing method. The principal is the sediments recorded the information of the past climatic variety when the saline was in the process of the saline evolvement to dry saline. This information can be detected by remote sensing image, which can be collected from remote sensing image and corresponding field profiles. After image processing, time-space transition, correcting, and validating, we can establish the climatic variational curves with time-space corresponding relationship, which can compare with other proverbial results.

Based on above analysis, we can establish the geophysical model using saline shrinking representation time evolutive direction and the dark-bright variety of image zone hue corresponding past time cold-warm change. If we don't consider hypsographic affection to zones, and the late lake water rising to the changes of former sediments, assuming shrink speed as a constant, the width of image zone is corresponding to the time. Thus, when we ascertained the start-ending time of saline shrink, we could establish the curves of past climatic changes.

4 .Preliminary results and acquirement

The preliminary results are showed in figure 2. It is the climatic change curve of Luobupo saline about 2000 years, which has showed the periodic change of past climatic one and two hundred years.

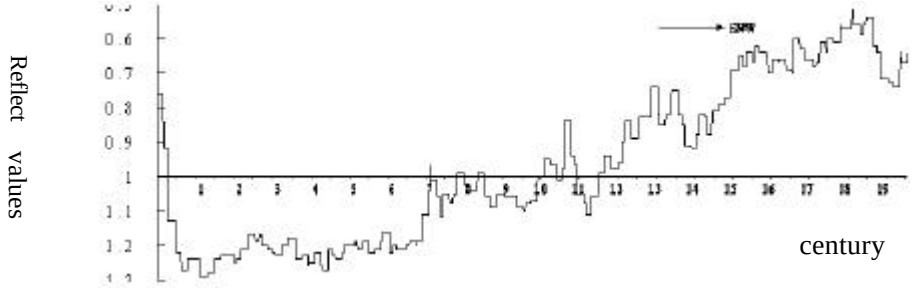

Fig. 2 The climatic change curve of Luobupo saline about 2000 years

There are obvious reflection of 5th century cold period, 7th century cold period, 9th century cold period, 12th century strong cold period, and middle ages warm period. We compared the climatic change curve of Luobupo saline (see figure 3A) to that of Guliya ice core[3] (see figure 3B) on 100 year time scale, we can find that there are tendency of change warm on 1000 year time scale,

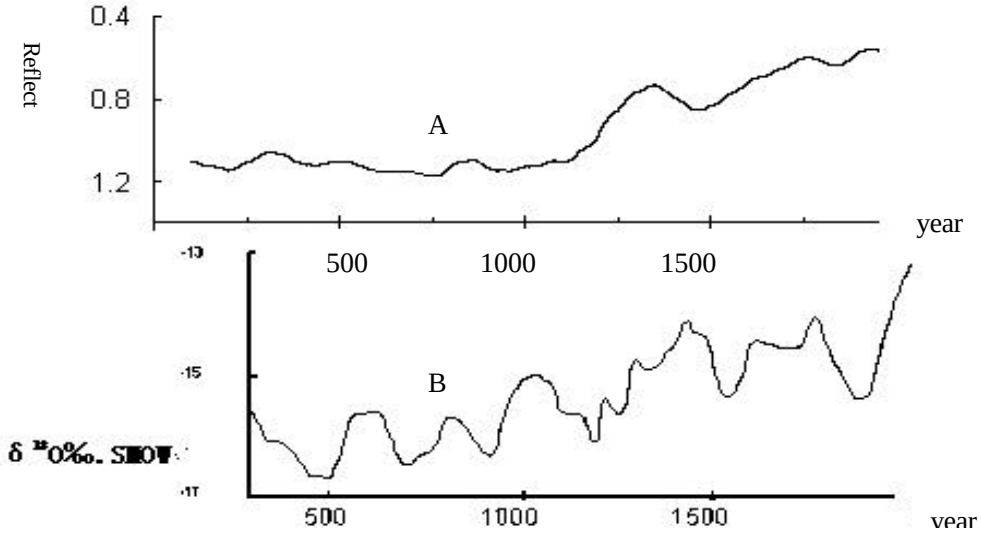

Fig .3 The climatic change curve of Luobupo saline(B) and Guliya ice core(A) about 2000 years

and there are nice corresponding of past 1000 years climatic change on 100 year time scale, there is comparability of middle ages warm period, 15th century and 18th century low temperature periods.

Fig 4 It is the high frequency curve of the climatic change in past 1000 years in Luobupo

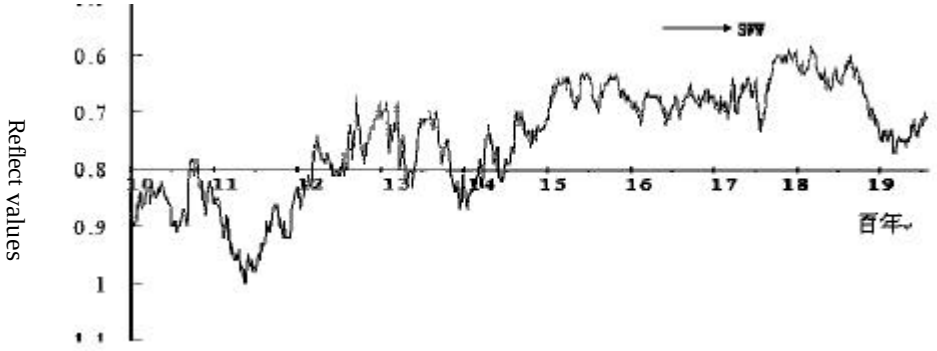

Fig 4 The high frequency curve of the climatic change in past 1000 years in Luobupo saline.

Saline. There are 6 low temperature periods and 5 high temperature periods on the temperature change of climatic oscillation on 100 year time scale in west of china in past about 1000 years. The valley values of low temperature are in A.D. 1100s (1100-1109), 1310s, 1480s, 1680s, 1830s, and 1950s, respectively. The peak values of high temperature are in A.D. 1220s, 1390s, 1570s, 1780s, and 1900s, respectively. The variational period is between 120 and 210 years[4]. The comparison of the acquired results showed that 6 low temperature valley values are corresponding to the data, and 5 high temperature peak values are partial corresponding to the data. The low temperature valley values are nice corresponding to the historic recordation which is that it could run carriages on the ice surface of Tai lake in 1111, it iced cover on south Suzhou canal in 1170, and the litchis were frozen to death in 1178 in Fujian province. There are two corresponding trough on the curve. It froze on Tai lake in 1329, there are four times freeze on Tai lake, Hanshui, Huaihe and three times freeze on Dongting lake in between 1650 and 1715[5]. There are obvious four times fluctuation on the curve, and is corresponding to the cold period in 1725. There are many troughs and crests which represent the climatic events to be studied in 10 to 20 years periodic variety.

Based on above analysis, we consider that the variational characteristics of low frequency on Luobupo saline past 2000 years climatic change curve are consistent with that on western historical climate curve and Guliya ice core curve, i.e. large scale changes are consistent with regional changes. The frequency variety reflected the fluctuation of historical climate in eastern of China, the research result supported this view in southern Xinjiang[6].

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