Analysis of Soil Geochemical Characteristics in Delingha-Wulan Region, Qinghai Province

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Abstract: The research on the geological background of the main work areas has importance effects on the study of the geochemical distribution characteristics of soil elements. It is the key to finding out the deep-seated causes of geochemical characteristics, and also related to the depth of research on ecologically geochemical evaluation, characteristic agricultural planting, and the scientific nature of development planning. The 1: 50,000 soil measurement was used in this study to obtain high-precision test data of 28 elements and indicators in the work areas. Through the abundance of soil elements, the affinity between elements, the combination and distribution characteristics of elements in different geological units and different types of used land, cluster analysis and other data processing methods are used to discuss the soil geochemical characteristics of Delingha-Wulan. The meaning of the geological and ecological environment represented by it was also inferred on this basis.

1. Introduction

The work areas are located at the northeastern edge of the Qaidam Basin, with obvious natural geographical zoning. The Qaidam Basin is high in the west, low in the east, wide in the west and narrow in the east. The Kunlun Mountains are to its south, the Qilian Mountains to it north, the Altun Mountains to the northwest, and the Riyue Mountains to its east, forming closed inland basin. The folds of the northern and southern mountains of Wulan County cut the county into three closed-flow mountain basins: Chaka Basin, Xisai Basin and Bulanggou Basin. The Xisai Basin is the main development area of oasis agriculture in the Haixi region.

2. Characteristics of Lement Content and Enrichment Dispersion

The 1:50,000 surface soil measurement results in the surveyed areas were used to count the average values and variation coefficients of the original data of 28 elements. Comparing the research data with national soil-related parameters will help to understand the abundance, deficiency and enrichment of soil elements in the region, and further improve the abundance, deficiency and enrichment of soil elements in various regions of the province at the same time.

2.1 Characteristics of Geochemical Element Content

The soil geochemical background value is the background value of the element in the man-made environment greatly affected by human activities. In this research, it is defined as the average value $\overline{X}2$ by using $\overline{X}1\pm3S1$ to repeatedly eliminate the abnormal values of the element content in the surface sample $\overline{X}1$. It reflects the characteristics of the actual value of the current situation of element and serves as a reference system for measuring changes in environmental quality in the future.

(1) Contrast characteristics of background values between the surveyed area and the country

The value of K_1 is the ratio of the soil background value in the surveyed areas to the national soil background value. Compared with the national soil background value, the elements with K_1>1.2 are Al2O3, CaO, Cd, Cl, F, K2O, MgO, N, P, S, Sr, Fe2O3. The indicators of some elements like organic matter and pH are significantly higher than the national level. The background values of CaO, F, MgO, S and organic matter show extremely high levels, which can reach several times the

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national soil background value. These data reflect the general characteristics of extensive salt lakes and extremely rich salt substances in the Qaidam Basin. The high organic matter is related to the fact that most of the work areas are agricultural cultivation areas.

Elements with $K_1<0.8$ include Ge, Hg, Mo, and Se. On the one hand, the lack of these elements is related to the geological background of the working areas, and on the other hand, it is related to the geochemical characteristics of the elements. The lack of heavy metal elements such as Hg indicates the clean soil environment in the work areas.

(2) Comparison characteristics of background values between the surveyed areas and Xining surroundings

The value of K_2 is the ratio of the soil background in the measured areas to that in Xining and surrounding areas. Compared with the background value of Xining and its surroundings, the elements with $K_2>1.2$ are organic matters. The high organic matter value is related to farming in the work areas, while Xining and surrounding areas are characterized by frequent land use.

The elements with $K_2<0.8$ include Cl, Hg, N, and S. On the one hand, the lack of these elements is related to the geological background of the working areas, and on the other hand, it is related to the geochemical characteristics of the elements. The lack of heavy metal elements such as Hg reflects the relatively clean soil environment there. Frequent human and industrial activities in Xining and its surrounding areas are also important factors affecting its content. N and other elements are slightly lower than Xining and surrounding areas, indicating that the soil fertility in the surveyed areas is slightly lower than Xining and surrounding areas, which is closely related to the industrial structure of each region.

(3) Comparison characteristics of background values between the surveyed area and the northern part of Qinghai Lake

The value of K_3 is the ratio of the soil background value in the surveyed area to that in the northern part of Qinghai Lake. Compared with the background value in the northern part of Qinghai, the elements with $K_3>1.2$ include Cl, Sr, MgO and CaO, which is related to the common salinization in this work areas. Salinization can be seen everywhere in the arable land in the work areas. The northern part of Qinghai Lake is relatively wide, and salinization is mostly concentrated around Qinghai Lake and other lakes.

Elements with $K_3<0.8$ include N, S, organic matter and C. The lack of these elements is not only related to the geological background of the work areas, but also related to the type of land use in the surveyed areas. The observation area is mainly planted with special cash crops such as wolfberry, while the Qinghai Lake area is mostly covered with lush shrubs and other kinds of vegetation. The organic matter and C in the measured areas are slightly rich, which is closely related to the vegetation characteristics there.

(4) Comparison characteristics of background values between the surveyed area and Haidong area

The K_4 value is the ratio of the soil background value in the measurement area to that in the Haidong area. Compared with the background value in Haidong area, the elements with $K_4>1.2$ include Cl, I, S, Sr, Na2O and organic matter, which have a certain relationship with the salinization that is common in the work areas. Salinization can be seen everywhere in the cultivated land in the work areas. The Haidong area is dominated by chestnut soil developed on both sides of the Huangshui Valley, with high clay content and no salinization.

There is no element with $K_4<0.8$.

(5) Comparison characteristics of background values between the surveyed area and Hualong-Xunhua area

The value of K_5 is the ratio of the soil background value in the measured areas to that in the Hualong-Xunhua area. Compared with the background value in Hualong-Xunhua area, the elements with $K_5>1.2$ include Cd, Hg, I, Mo, N, P, S, Se, Sr, CaO, organic matter and C. The high levels of heavy elements such as Cd and Hg have a certain relationship with human activities around the surveyed areas. The scale in Hualong-Xunhua work areas is 1:250,000. The work areas are basically mountainous, and a small number of the work areas are in the farming area and human activity area, so the heavy metal content in these measured areas is slightly high. The fertility elements such as N and P are slightly high, which is mainly related to the cultivated land in the work areas. Se, S and Sr are higher than those in Hualong-Xunhua area, which is mainly related to the widespread salinization in the areas. The widespread existence of lake sediments is also the main factor influencing the high Se element in the Hualong-Xunhua area.

There is no element with K_5

2.2 The Enrichment and Discrete Characteristics of Elements

The coefficient of variation (CV) reflects the enrichment and dispersion characteristics of elements. The CV of each element in the whole work areas is generally small, indicating that the soil forming process there is relatively continuous and less affected by external factors.

In addition, the CV of Cl, S, Pb and Hg is relatively large, reflecting that these elements are easier to enrich and form high-value areas in local areas. The large changes of Cl and S are mainly related to the extensive accumulation of salt in the southern margin of the work areas near the salt lake. The large changes of Pb and Hg are related to the local enrichment caused by human activities.

3. Combination Characteristics of Elements

The distribution of elements in the soil is affected by various factors such as geological background. Cluster analysis of elements in the work areas can reflect the intrinsic geochemical properties of the elements, reveal some geological information, and explore the affinity between elements.

The indexes of 28 soil elements in the whole region were used for R-type cluster analysis, and a pedigree diagram of element cluster analysis (Figure 2-1) was made to discuss the close relationship between elements.

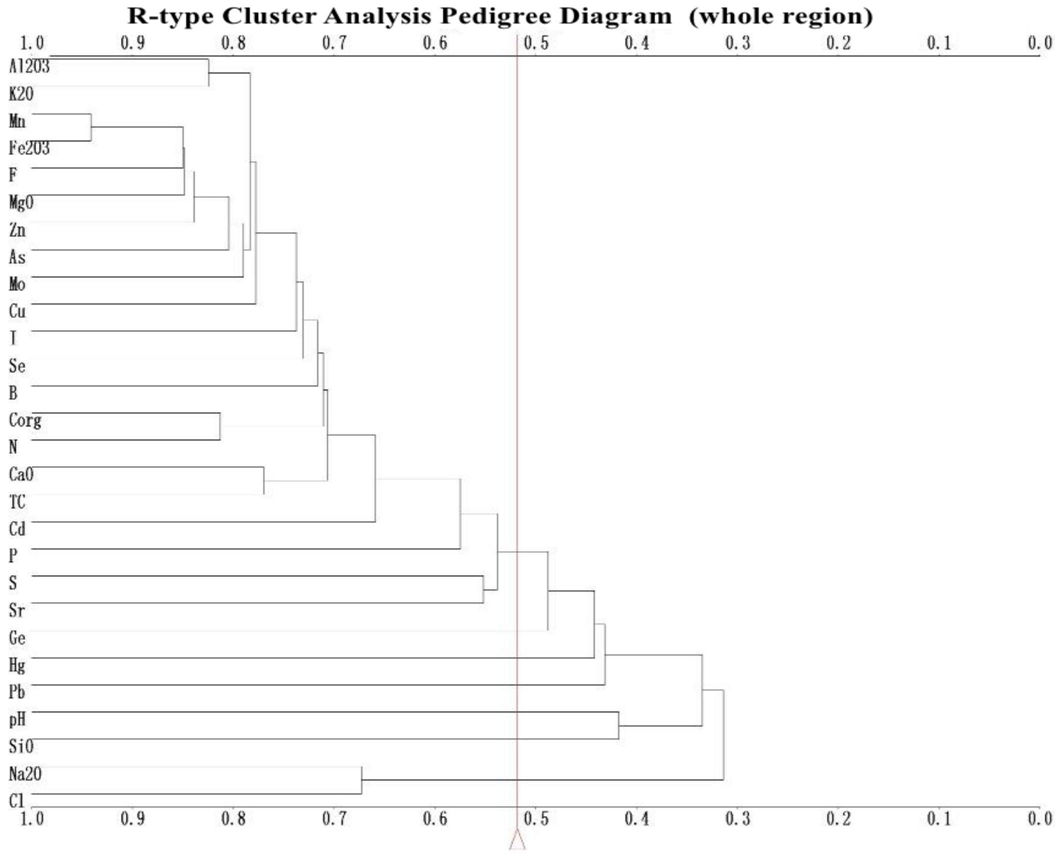

Fig.2 -1 Cluster Analysis Diagram of 28 Elements in Surface Soil of Working Area

In the R-type cluster analysis, all elements are divided into 7 clusters. The composition of Cluster Ⅰ is very complicated, and it is also the largest cluster, which can be subdivided into multiple sub-clusters. The elements such as K, Fe, Al, Cu, Zn and Mn in the soil are also well correlated in this cluster, which is closely related to the parent material of the soil. The northern part of the work areas is the Qilian Mountains. Richer minerals there provide a certain material source for the formation of soil. In addition to better vegetation coverage, cultivated land is also an important place for organic matter accumulation, which is closely related to human factors.

Cluster Ⅱ is Ge, which has poor correlation with other elements, reflecting its relatively independent distribution characteristics in the surface soil.

Cluster Ⅲ is Hg, and Cluster Ⅳ is Pb. They obviously are enriched in the surrounding areas of major cities and towns, which is related to the pollution caused by human production and life.

PH in Cluster Ⅴ directly reflects the PH value of the surveyed areas.

Cluster VI is SiO2, which reflects the characteristics of the soil itself.

Cluster VII is the combination of Cl and Na2O, which shows the widespread salinization of the soil in the work areas.

4. Spatial Distribution Characteristics of Elements

4.1 Spatial Distribution of Soil Elements

Based on the study of soil element abundance, enrichment discrete characteristics, combination characteristics and distribution characteristics in different units in this area, and combining with the spatial distribution of elements in the geochemical map, it can be preliminarily determined that the spatial distribution of elements in this area is mainly affected by factors such as geological background, soil formation process, parent material and agricultural cultivation. And the geochemical field characteristics of the elements in this area have been formed under the combined action of these influencing factors.

4.2 Element Geochemical Characteristics of Different Quaternary Units

The work areas present obvious characteristics of quaternary development. Combined with the results of the 1:10,000 route geological survey, the soil element content of the different quaternary units in the eight main work areas was counted and the geochemical characteristics of the soil in the main geological units were analyzed, so as to discuss the exact relationship between soil element enrichment and depletion and quaternary units.

4.3 Element Geochemical Characteristics of Different Soil Types

The soil elements of different soil type units in different work areas were counted to analyze the element geochemical characteristics of different soil type units, and the analysis results can show the enrichment and depletion trends of elements in different soil types. Since the collection areas belong to the farming area, brown calcium soil is the main soil type, followed by saline soil and gray brown desert soil.

5. Soil Vertical Geochemical Characteristics

The vertical soil profiles set in 2016 were to understand the main soil types in the work areas as well as the soil composition and element distribution of soil parent materials, which is an important basis for studying soil geochemical characteristics and evolution laws there.

There are 6 main soil types involved in Delingha-Wulan, which respectively are alpine steppe soil, brown calcic soil, gray-brown desert soil, solonchak, bog soil and aeolian sandy soil. Summarizing the change characteristics of vertical soil elements in the whole area is helpful to understand the geochemical characteristics of the vertical soil profile in the work areas.

5.1 Alpine Steppe Soil

This is the soil type with the largest distribution area in the area, and it is widely distributed in the north of the work areas and the Wulan area. Mountain rivers have quite long bodies of water in the distribution areas, which are important material sources for the alluvial plains downstream of the rivers. A total of 9 profiles were deployed in this soil type in 2016, and now a typical profile CP15 is selected to make a preliminary summary of the law and characteristics of element changes in the vertical direction of this soil type.

Among the soil constituent elements, SiO2, Al2O3, CaO, MgO and Na2O have little change, and the vertical content is stable. Cl, S and Fe2O3 change greatly. Cl shows a significant increase trend between 0cm and -90cm, a large change at -100cm, and an unstable change between -100cm and -200cm. The overall content of S varies greatly between 0cm and -200cm. Fe2O3 has a big change in the surface layer, and the content changes stably as it goes down. As a whole, the vertical content of soil constituent elements does not change much.

The content of the other beneficial trace elements and life and health elements is relatively stable, except for B, Mo, Sr and I.

In terms of the toxic and harmful elements, Cd, Hg and Pb are stable in content; As shows relatively great changes between 0cm and -120cm, and the content below -120cm tends to be stable.

5.2 Brown Calcic Soil

brown calcic soil is an important soil type in the region, and its distribution area is an important source of soil parent material for farmland. It is distributed in strips in the middle of the work areas. In 2016, 9 sections were deployed in this soil type, and in this research, the CP1 profile was chosen to make a preliminary summary of the law and characteristics of the vertical elements of the soil type.

Among the soil constituent elements, the content of Na2O and SiO2 is relatively stable, while the content of Al2O3, CaO, MgO and Fe2O3 changes little. The content of Cl and S decreases between 0cm and -20cm, and it changes steadily between -20cm and -200cm.

The content of beneficial trace elements and life and health elements change significantly, except for Mn, Mo, Cu, Sr and Ge. B and Zn varies greatly between -100cm and -120cm. The content of F decreases between 0cm and -20cm, increases again between -20cm and -100cm, and the range of change is very large between from -100cm and -200cm. Se and I have the same changing trend. The content of Se in the surface soil is general, and the content value below -30cm is higher than that in the surface soil.

In terms of toxic and harmful elements, the content of Cd and Pb is stable, while the changes of As and Hg are relatively large, without any obvious law.

5.3 Gray-Brown Desert Soil

Gray-brown desert soil is a unique soil type in the Qaidam Basin, which is mainly distributed in northern Delingha. This type of soil is distributed to varying degrees in Huaitutara, Delingha and Xuji Township. The parent material of gray-brown desert soil is mainly sandy alluvial deposits or slope deposits.

Three profiles were deployed in this soil type in 2016, and the CP2 profile was selected in this research to make a preliminary summary of the law and characteristics of element changes in the vertical direction of this soil type (Figure 4-24).

Among the soil elements, the content of Al2O3, CaO, MgO, Na2O, SiO2 and Cl is relatively stable, and their content curves do not change much. The curve of Fe2O3 and S content changes greatly. It can be seen from the Fe2O3 curve that its content is stable between 0cm and -50cm; between -50cm and -100cm, it first increases and then decreases, with obvious changes. The content of S increases first, and begins to obviously decrease when it reaches -40cm; the content tends to be stable when it reaches -80cm, and changes greatly between -140cm and -200cm.

The content curves of beneficial trace elements and life and health elements change greatly, except for B, Mo, Sr and Ge. The change trends of Mn, Cu, Zn, Se and I are similar. They all increase in content between 0cm and -50cm, and decrease again between -50cm and -100cm, and then tend to stabilize. The F content varies significantly from -120cm to -140cm, with large range.

In terms of toxic and harmful elements, the content of Cd and Pb is stable, while the changes of As and Hg are relatively large, without any obvious law.

5.4 Solonchak

Solonchak is distributed in a large area in the southwest of the work areas, mainly distributed in the downstream of the main farming area. Two profiles were deployed in this soil type in 2016, and CP12 profile was selected in this research to make a preliminary summary of the law and characteristics of element changes in the vertical direction of this soil type.

The soil constituent elements with relatively stable content are Al2O3, Na2O, SiO2, CaO, and Cl. The content curves of Fe2O3 and MgO are similar. Their content values first decrease and then tend to stabilize, with great changes between -170cm and -200cm. It can be seen from the curve of S that its content is stable between 0cm and -40cm, suddenly becomes larger at -50cm, then gradually becomes smaller, and then stabilizes again.

Except for F, Se, Sr, Ge, I, Zn and Cu, the content curves of other beneficial trace elements and life and health elements change greatly. It can be seen from the graph that the content changes of B, Mn, and Mo have no obvious regularity.

In terms of the toxic and harmful elements, they present slight changes, except for As.

5.5 Bog Soil

Bog soil is mainly distributed in the south of Keluke in the work areas and near the rivers connecting to the Tuosu Lake. A profile was deployed in this soil type in 2016, and the sampling number was CP4, with the purpose to make a preliminary summary of the law and characteristics of element changes in the vertical direction of this soil type.

In term of the soil constituent elements, the content of SiO2 is relatively stable; the content curve of CaO shows an extreme value at -50cm, and does not change much at other depths; the content curves of Al2O3, Fe2O3 and MgO change in a similar way. Their content gradually increases from 0cm to -30cm, and decreases again from -40cm, and then tends to be stable; with the change of depth, their content gradually decreases. The content of Na2O, Cl and S changes similarly.

Among beneficial trace elements and life and health elements, the content of Cu and F content change similarly; Se, I, and B change similarly.

The content of Zn and Mn change similarly; that of Ge does not change much; the content of Mo has no obvious change law, and the content becomes larger and stabilized below -80cm.

The content of toxic and harmful elements has similar changes, except for As,

5.6 Aeolian Sandy Soil

Aeolian sandy soil is scattered in the work areas. Due to the strong wind transport in the Qaidam Basin, the farmland is inevitably affected by the aeolian sandy soil. In 2016, two profiles were deployed in this soil type, and CP8 profile was chosen in this research to make a preliminary summary of the law and characteristics of the vertical elements of the soil type.

Among the soil constituent elements, SiO2, CaO, Al2O3, Fe2O3, MgO and Na2O are relatively stable in content. It can be seen from the content curves of Cl and S that they have similarities in content changes.

The content of beneficial trace elements and life and health elements is stable, except for I.

In terms of the toxic and harmful elements, the content of Cd and Pb shows a maximum at -30cm, and the content of samples collected at other depths changes steadily.

6. Conclusion

The project "*Ecological Geochemical Evaluation of Oasis Agriculture in Delingha-Wulan, Qinghai Province*" was successfully completed in two years from March 2016 to March 2018. The project adopted technical methods and means of green survey, and conducted multi-media sampling and analysis around the soil, plants and water bodies in the oasis agricultural area of Delingha-Wulan. The analysis results preliminarily determined the geochemical distribution and distribution characteristics of the elements in the surveyed areas, and delineated a batch of beneficial and harmful element anomalies. This project selected typical anomalies for verification, and then combined with the migration and transformation laws of elements in soil, plants and water bodies to provide basic information for land quality and ecological management and protection, agricultural planting structure adjustment, and environmental pollution control in the Qaidam Basin. It serves the sustainable development of local economy and society.

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