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学 位 論 文 要 旨

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題目: Study on farmland salinization and its mechanism in the Loess Plateau
(黄土高原における農地の塩性化とその発生メカニズムに関する研究)

In this thesis the research conducted in two case studies are mainly presented. The first one discussed about the recharge source and movement of water and salt by the chemical analysis and stable isotope technology in the eastern block of the Luohui Irrigation District, China, and would find the best way to prevent soil salinization. The second one discussed about the soil salinization by soil texture and chemical analysis in check dam farmland in the Loess Plateau, China. This research laid a scientific foundation for studying salt and water movement, preventing salinization and allocating the utilization of canal systems and wells for reasonable water resources management.

The source and movement regularity of water and salt in the eastern block of the Luohui Irrigation District (32,000 ha) of the Loess plateau, China, have been studied, with an emphasis on relating geographical characteristics (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, NO_3^{-}, HCO_3^{-}) and stable isotopes factors ($\delta^{18}O$, $\delta^{2}H$). Subsequently, we evaluated the sustainability and effects of saline soil improvement by warp soil dressing. The followings were some main results of our study:

(1) We established the local meteoric water line (LMWL) and the Luo River water line (LRWL). In summer, the recharge source of groundwater was mainly controlled by the groundwater depth (vertical distance between ground surface and groundwater level; GD): GD < 3m, the recharge source of groundwater come mainly from precipitation, but GD > 3m, mainly received the irrigation water from Luo River; In winter, the recharge source of groundwater was mainly controlled by the existence of fluvial terraces: in the first terrace and the second terrace, the recharge source of groundwater was mainly from Luo River water, but in the area of the third terrace come mainly from deep groundwater which was isotopic depletion. Moreover, the $\delta^{18}O$ and $\delta^{2}H$ isotopes of groundwater in the study area had obvious seasonal variation characteristics, and had received certain evaporation effects when the groundwater accepted recharge from precipitation and the Luo River. Finally, we used a two-component separation model based on the water and tracer (oxygen isotope) mass balance to determine the relative contribution of precipitation and Luo River water to groundwater.

(2) The chemical type of groundwater in the eastern block of the Luohui Irrigation District was relatively single and mainly $Cl^{-}\cdot SO_4^{2-}-Na^{+}$, then was $Cl^{-}\cdot SO_4^{2-}-Na^{+}\cdot Mg^{2+}$. According to the relationship between the chemical characteristics of groundwater and the depth, we found the salt of groundwater come from the deep groundwater (below 15 m depth from the groundwater level) because the bottom of the Luohui Irrigation District has the massive soluble salts at 40−50 m in depth from ground surface. The effect of evaporation and condensation was not the control elements of chemical characteristics formation of groundwater in the saturation zone, but the brine invasion from the deep groundwater and human activity was the main reason for the formation. Subsequently, we used the chemical and stable isotope ($\delta^{18}O$, $\delta^{2}H$) characteristics of groundwater (Depth > 15 m

depth from groundwater level) in the Luohui Irrigation District to get the deep groundwater water line (DGWL). Meanwhile, combining the LMWL and the LRWL with the two-component separation model, we calculated the proportion of recharge source in groundwater for each well.

(3) We taken some soil water from soil samples by the high speed refrigerated centrifuge when the moisture content of soil sample > 20%. According to the chemical and stable isotope ($\delta^{18}O$, $\delta^{2}H$) characteristics of soil water, the stable isotope of the soil water in depth (depth ≤ 100 cm) from ground surface was enriched by evaporation effect. In the shallow depth (depth ≤ 5 m), the salinity from the soil water stay temporarily in soil layers between 100 and 200 cm. Meanwhile, the soil water above 300 cm in depth was composed of precipitation and Luo River water, the sources of salinity come from Luo River water (irrigation water) through infiltration. However, soil water below 300 cm was composed of groundwater and Luo River water, the sources of salinity mainly come from the groundwater through capillary water rise. In the deep depth (depth ≥ 5 m), the salinity from the soil water stays temporarily at 200, 300 and 400 cm. The sources of salinity might come from Luo River water (irrigation water) which such practice in longer period of time causes for accumulation of salinity in the soil. The soil water below 300 cm was only Luo River water. Finally, according to the two-component mixing model, we calculated the composition of the soil water.

(4) The warp soil dressing was an effective method to rehabilitate saline land and improve soil chemical and physical properties from salinization. It not only could effectively prevent soil salinization, but also formed the cultivated land. Consequently, the short-term effect of saline soil improvement using warp soil dressing was feasible, but not sustainable.

Using Caomao check dam in Zizhou County, Shaanxi Province, China, as the study area, we investigated the fluctuation of groundwater level and soil salinization in check dam farmland, and the results are concluded as following:

(1) The groundwater level is greatly influenced by precipitation. It is caused by infiltration of surface runoff from the lateral slope into groundwater in the farmland of Caomao check dam.

(2) The groundwater level has a tendency to rise in winter and to decline in spring. The tendency has close relationship with temperature. Consequently, the soil salinization is caused by the frozen soil start to melt, the amount of evaporation increase, and the high groundwater level.

(3) The process of soil salinization is mainly due to the frozen soil melt in spring which is frozen in winter, and high groundwater level combined with capillary water rise which is caused by the high amount of evaporation in summer.