地理学报(英文版) 2002年第12卷第3期

Copper content and its distribution in soils of Tibet

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The copper (Cu) content in 205 soil samples (0-20 cm) of Tibet, covering 5 soil classes, were analyzed. The results showed as follows: (1) the average content of Cu was 19.6 mg kg-1 (CV=49.28%); (2) the content of Cu in Tibetan soils was lower than the average level of China; (3) the content of Cu gradually decreased from the southeast to the northwest which was consistent with the direction of changes in the zonal successions of soil in Tibet; (4) Cu contents in Tibetan soils varied with soil properties, particularly soil parent materials that Cu contents were remarkably enriched in soils derived from shale materials.

Copper content and its distribution in soils of Tibet ZHANG Xiaoping1, YAN Xiuyi2, YANG Xueming1 (1. Changchun Institute of Geography, CAS, Changchun 130021, China; 2. Jilin University, Changchun 130026, China) Abstract: The copper (Cu) content in 205 soil samples (0-20 cm) of Tibet, covering 5 soil classes, were analyzed. The results showed as follows: (1) the average content of Cu was 19.6 mg kg-1 (CV=49.28%); (2) the content of Cu in Tibetan soils was lower than the average level of China; (3) the content of Cu gradually decreased from the southeast to the northwest which was consistent with the direction of changes in the zonal successions of soil in Tibet; (4) Cu contents in Tibetan soils varied with soil properties, particularly soil parent materials that Cu contents were remarkably enriched in soils derived from shale materials. Key words: copper; soil; Tibet CLC number: S153.6 1 Introduction At present the ecological environment of Tibet almost remains in protogenic state. It is amongst few places in the world that are the least influenced by human activities. Therefore, Tibet is an ideal place for doing research on the environmental background inspection and surface layer geochemistry. The data of Cu contents in Tibetan soils can not only contribute to further studies of the geochemical features of Cu in the biosphere of the Tibetan Plateau but also provide some fundamental information for checking environmental background of Cu in Chinese soils and even soils of the world. Two hundred and five top layer (0-20 cm) soil samples were collected from the Tibetan Plateau. All these samples were from the remote regions (far away from human activity) of Tibet: the Jinsha River in the east to the Bangong Co in the west; the Tanggula Mountain Pass in the north to Yadong, Zhangmu, Gyirong, Burang in the south (Figures 1 and 2). The samples were screened through a 2-mm nylon sieve (gravels larger than 2 mm was removed), then ground to one hundred mesh. Soil samples were digested with hydrochloric acid ?Cnitric acid?Chydrofluoric acid?Cperchloric acid. The Cu content of samples was measured with flame vapor atomic absorption Spectrophotometer (HITACHI?C180-80) at a wavelength of 324.8 nm. The inspection limit of the instrument was 0.195 ?滋g/ml-1. The content of soil organic matter was determined by K2Cr2O7 method. A ratio 2.5:1 of water to soil was used in determination of soil pH value. The mechanical composition was measured with hydrometer. 2 Results and discussion 2.1 The Cu content and distribution The Cu contents of Tibetan soils followed the log normal distribution and were consistent with results reported by others (Wei, 1990). It can be seen clearly from the statistic results (Table 1) that the average content of copper in the surface soil of Tibet is slightly lower than that of the whole country, and obviously lower than the value of Clarke. Due to the great variations in soil framing factors (such as parent material, topography, climate, and biology) and the difference in behavior of the trace element´s migration and accumulation in Tibetan soils, the distributions of soil Cu content varied greatly in different regions and among different soil groups. These differences existed both horizontally and vertically. The tendency of Tibetan topography rises gradually from southeast to northwest. The conditions of moisture and temperature change gradually from warm humid to dry cold. The soil types and vegetation distribution evolve mainly along the direction from southeast to northwest. For example, from southeast to northwest lies consequently diffe rent vegetation belts of tropical and subtropical montane forest, montane shrubby grassland, alpine meadow, alpine steppe, alpine frigid desert grassland, and alpine desert grassland. All samples were taken from these vegetations such as alpine sparse cushion vegetation, alpine steppe, alpine meadow, alpine desert steppe, subalpine desert, montane shrubby meadow, dark needle-leaved forest, needle- and broad-leaved mixed forest, evergreen broad-leaved forest, seasonal rainforest, meadow and swamp. From Jinsha River to Nyainqentanglha Mts., the Tibetan soil type changes in such an order as drab soil, brown earth, sub-alpine meadow soil, alpine meadow soil, alpine steppe soil and alpine desert soil. It can be seen that the content of Cu decreases gradually in the direction from southeast to northwest along with the direction of the evolution of the soil types (Table 2). The data indicate that the contents of copper in Tibetan soils are closely related to the dip of Tibetan topography and the changing tendency of the temperature and moisture and even to the horizontally zonal distribution of the soil. The Cu contents (geometric mean) in surface soil of each watershed in Tibet are 23.43 mg/kg in Yarlung Zangbo River valley > 21.18 mg/kg in Three-River valley (Jinsha, Lancang and Nujiang rivers) > 17.84 mg/kg in Shiquan River valley > 16.13 mg/kg in interior drainage area of the plateau. Besides the general trend mentioned above, displayed by the content of Cu in the surface soil of Tibet along with the changes of geographic regions and soil types, there are some independent dot-shaped or awl-shaped areas where the contents of Cu were extremely higher or lower than those in the surroundings because of strong influence of soil parent materials, such as the regions like Anduo, Nierong, Dangxiong at the south foot of Tanggula Mountains where the Cu contents are far lower than the average. There were 10 samples with Cu contents less than 8.95 mg/kg and among them 6 were only about 6.40 mg/kg. In northern Tibet (Geji and Cuoqin), there were two dot-shaped lower points. In southern Tibet (Shangchayu), there is one awl-shaped lower region. In the upper and middle reaches of the Yarlung Zangbu River, Saga, Bailang, Jiangzi, Nimu, Milin, Luozha, Jiacha, Cu was enriched as banding-shaped areas. Ten samples contained high Cu levels of over 41.50 mg/kg and among them 8 samples contained the highest level over 102.70 mg/kg. Compared with other types of soils, the average Cu content in drab soil is the highest, and in saline soil is the lowest. 2.2 The vertical distribution of Cu content in Tibetan soils Due to special topography and soil forming environments in Tibet, the distributions of Cu in Tibetan soils showed obvious vertical variations, the same as the horizontal variations. Just as mentioned above, the direction of the horizontal distribution of soil Cu in the Tibetan Plateau was similar to the horizontal zonal distribution of Tibetan soil ?C from southeast to northwest caused by the gradual rise of the topography in the direction. So the horizontal zonal distribution of Tibetan soils actually restricted some compositional features of vertical zonal distribution of soils at the same time. This shows a phenomenon that the horizontal zonal distribution of Cu in Tibetan soils itself contains the factor of the vertical distribution. The vertical distribution of Cu varied with soil types and here we take only Chayu area as an example. In Chayu soils were dominated by yellow earth in the low elevation, and soil types changed to yellow?Cbrown earth, brown earth, dark brown forest soil and sub-alpine meadow soil with the rise of elevation. All soils were derived from igneous rock except a brown-earth that parent material was sedimentary rock. Table 3 shows that Cu content in the surface soil does not appear to have regular variation with the rise of elevation. But Cu content in the surface soil of vertical zone in this area was relatively low. The average value was only 14.51 mg/kg. 2.3 The main factors influencing the content of Cu in soil The Clarke value of Cu in the earth´s curst is 55.00 mg/kg. There are great differences in the Cu contents among different rocks; for example 45.00 mg/kg in shale, 30 mg/kg in fine sandstone, 20 mg/kg in granite, and only 10.00 mg/kg in basic igneous rock. Cu contents in Tibetan soils derived from shale was outstandingly higher than those of soils developed from other parent material. The order of Cu contents in soils derived from different parent materials followed the trend of shale > diluvial deposit, gray rock or sandstone > tillite, granite, basic igneous rock and lacustrine sediments. The order is basically identical to the content of Cu in the corresponding soil parent material. Based on the above discussion we can see that the horizontal distribution of Cu was closely related to horizontal distribution of soil parent materials. For instance, in the upper and middle reaches of the Yarlung Zangbu River, Saga, Bailang, Jiangzi, Nimu, Milin, Qushui, Luozha, Tiacha, there were banding-shaped areas concentrated in Cu, which is likely related to the fact that the main soil parent material in these areas is metamorphism rock. On the other hand, the contents of soil Cu was relatively low in vertical zone of soils in Chayu, and it is likely related to the fact of igneous rock in this area. 2.4 The correlation analysis of the factors Soil is an integrated natural body formed from parent material subject to the multiple influences of soil-forming factors as biology, climate, topography and time. The soil-forming processes and soil properties directly influence the level of the element contents of soils. In order to find out the relationship between Cu content in Tibetan soils and soil properties, the correlation of Cu to organic matter, pH value and soil particle sizes were analyzed. The correlation analysis of the factors shows that the basic physiochemical properties of soil influenced the content of soil Cu which assumes the positive correlat ion with the silt (0.01-0.001 mm) and clay contents (<0.001 mm), and pH value, and it also shows the negative relationship to the coarse particle. Negative correlation to the fine particle and positive correlation to the coarse particle indicate the inheritance of soil Cu content to parent materials. 3 Conclusions About 95% sampling soils contain a Cu level ranging from 8.95 mg/kg to 41.50 mg/kg. The arithmetic mean, geometric mean, and the median of Cu contents of Tibetan soils are 21.9 mg/kg, 19.6 mg/kg, and 19.5 mg/kg, respectively. The average content of Cu in Tibetan soils is lower than the country´s average level, and is obviously lower than the Clarke value of Cu. In Tibet, the contents of soil Cu decreased gradually in the direction from southeast to northwest that paralleled to the direction of soil type variation and bio-climatic and ecological conditions. The soil Cu contents in the surface layer of each watershed in Tibet followed the trend of Yarlung Zangbo River valley > > Three-River valley > Shiquan River valley > interior drainage area. Regarding to the average Cu content in different soil types of Tibet, it is the highest in drab soil and the lowest in saline soil. The Cu content in the surface soil does not appear to have regular variation along with the rise or fall of elevation. The basic physiochemical properties of soil influence soil Cu content to a certain extent. The Cu contents of the soils developed from the different soil parent material differ obviously. The soil developed from shale has a much higher copper content than that from other parent materials. In the upper and middle reaches of the Yarlung Zangbu River, there is a high content of Cu banding-shaped area, which is likely related to the dominant parent materials--metamorphism rock in the area. On the vertical zone of soil in Chayu, the soil Cu contents were relatively low, which is probably due to the fact that igneous rock is as main parent materials in the area. References Alva A K, Obreza T A, 1994. Reactions of copper and sulfate in sandy soils under citrus grove and uncultivated conditions. Soil Science, 56-63. Cheng Yan´ao, 1993. Background Values of Elements in Tibetan Soil and Their Distribution. Beijing: Science Press, 65-67. (in Chinese) Geology Department of Nanjing University, 1972. Geochemistry (revised edn.). Beijing: Science Press, 78-81. (in Chinese) Liu Duosen, 1987. The Mathematical Method and Modeling in the Study of Soil and Environment. Beijing: Agricultural Press, 38-61. (in Chinese) Liu Yingjun, 1984. Geochemistry of Elements. 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关键词： copper; soil; Tibet

