Stability of Fe-Mn and blocking effects on the transformation of phases during soil development in the Hunchun Basin, China

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Based on the results about present concentrations and distributions of heavy metals through profiles, surface soils, and stream sediment samples in the Hunchun Basin, northeastern China, this area is suffering from combinative pollution; natural enrichment of Fe & Mn and anthropogenic contamination of Cd, Cu, Ni, and Pb originated from organic phosphate fertilizer and F leached from coals and ashes. The distribution of contaminants in the alluvial soils (fluvisol) of this area has been influenced by several interacting factors. This natural inheritance factor was supported by the fact that the concentration levels of weak acid (0.1N HNO_3) extractable (plant available) heavy metals were very low, except for Fe and Mn. Fe had a good correlation only with Cr and Zn in total digestion, however, Fe did with Zn, Pb, Mn, and Cu in weak acid extraction. Therefore, existing status of weak acid extractable Fe might control the behaviors of heavy metals in this area.

In order to evaluate the extent of natural enrichment of Fe and Mn over the whole Hunchun Basin, experimental analysis of the stability of Fe-Mn mineral phases, their existing status, weathering rate of source materials, and characterization of soil properties were performed. In comparison between first and second terrace, the first terrace in which more active weathering processes were held, had more smectite and gibbsite.

From the sequentially selective dissolution method using sodium pyrophosphate (*p*), acid oxalate (*o*), and dithionite-citrate-bicarbonate (DCB, *d*), Si, Al and Fe were dominant in *d* and *p* fraction, and Mn was *o* and *p* fraction respectively. Based on this result, existing phases and status of Fe and Mn were distinctly different, and abundance of amorphous Mn phases made thermodynamic calculation difficult. Differential X-ray diffraction (DXRD) during the sequentially selective dissolution revealed that coating materials which was originated from weathered products of granodiorite were ferrihydrite and goethite. Application of these ferruginous weathering products to understand basin development revealed that the first terrace of the Hunchun River is more active than the second terrace, which is inducted from the higher value in Fe_d/Fe_t. Amorphous Fe phases such as $Fe(OH)_3$ and $Fe_3(OH)_8$ were controlling factors of Fe from the thermodynamic calculations. These phases were hindered to more stable phases

to ferrihydrite or goethite by high contents of smectite and gibbsite, amorphous opaline produced from rice roots, and organic phosphate pesticides or fertilizers.

Considering the water analysis results, the source-rock deduction using surface water and ground water samples suggested silicate weathering by ionic ratio of HCO_3/SiO_2 and total dissolved solids (TDS), and granitic weathering by ionic ratio of Mg/(Mg+Ca). Precipitation around the Hunchun Basin became more acidic gradually. Therefore, in the future, it is inevitable that ecological and environmental problems related to the Fe phases probably occur in drinking water supply in this area, especially first terrace.

Key words: weathering, ferruginous products, sequentially selective dissolution, thermodymanic calculation

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