Impact of regional geology, land use and flow path on stream water chemistry in a small watershed

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Stream water chemistry is dependent on the physical, chemical and biological processes occurring in the watershed. Understanding the governing mechanism of the stream water chemistry in a watershed is the first step for the water quality management. The study area drains a total catchment area of 1.46 km^2 and consists of forest (80%), upland (15%) and rice paddy field (5%). The studied area has two distinctive bedrocks, quartzite and schist. We periodically collected the stream water samples at mainstream and tributaries and the pH, electrical conductivity (EC), alkalinity and the concentrations of cations and anions of the collected stream water samples were determined in the field and laboratory. The all collected water samples were nearly neutral and the EC and concentrations of Na, K, Ca, Sr, Si and HCO_3^- of the stream water samples collected from the schist terrain had greater values than those from the quartzite terrain. The mainstream running along the boundary of schist and quartzite terrains had the intermediate values of the tributaries. The stream water samples collected in and near the upland showed a high concentration of NO_3^- than those of forest regardless the lithology. The stream pathway was also directly reflected on the chemistry of stream water. The stream water drained in the forest of quartzite terrain had the lowest values of alkalinity, EC and concentrations of cations and anions but the stream water drain in the upland of schist terrain had the highest values of EC and concentrations of cations and anions, especially NO_3^-. The chemistry of stream water in the studied watershed was mainly controlled by the bedrock, land use and flow path.

Key words bedrock; alkalinity; EC; cations; nitrate

Characteristics of trace elements in contaminated rivers and their environmental significance

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Several rivers researched around Taihu Lake in Chinese eastern plain are distributed to the west of the lake. Pollutants of different types from tributaries and inlets flow directly into the main rivers and finally into the lake. They change trace elements of rivers from which we can analyze. Researches about trace elements are helpful for understanding the pollutant characteristics, industrial structure and agricultural cultivation in the area of network rivers in the plain of China. Samples of water column, suspended matter and sediment were collected from the west rivers of Taihu Lake, which represent three typical rivers. Observation in the field and the primary composition analysis showed the Caoqiao River was mainly contaminated by industrial wastewater, the Liangxi River was discharged by domestic sewage and the Dapu River was principally input by farmland runoff. REE concentrations and their normalized curves showed obvious characters for rivers discharged by different sewages. The contents of total REE in water column followed the order of the Caoqiao River, the Dapu River and the Liangxi River from high to low. TREEs in suspended matter and sediments follow the order of the Dapu River > the Caoqiao River > the Liangxi River. REE normalized curves (for Australia shale) suggested that significant diversities were presented in water column, suspended matter and sediments, i.e., heavy REE enrichment in water, middle REE enrichment in suspended matter, and smooth curves for sediments. But the heavy pollution resulted in several anomalous curves in the same rivers. Some element ratios were selected as indices for polluted rivers based on their geochemical properties and diversities between rivers. The results displayed the discriminative indices for water column, suspended matter and sediment. The effective indices were Pb/Fe, Cr/Fe, Ni/Fe, Pb/Ni, Zn/Ni for water column, Cu/Al, Cu/Fe, Zn/Fe, K/Ca, K/Na, Pb/Co, Zn/Co for suspend matter and Pb/Fe, K/Ca, Ca/Mg, Zn/Ni for sediment, respectively. In general, rivers mainly discharged by industrial sewage have high ratios of Pb/Ni, K/Ca, are enriched in the middle REE and have positive Gd anomaly. The domestic sewage flowing into rivers reveals high ratios of Zn/Ni, Pb/Fe, and is enriched in the heavy REE, and has the positive Eu anomaly. If runoff of farmland enters into the rivers, it will have high ratios of Ca/Mg, K/Na, high lanthanum, and show the smooth normalized curves of REE. Therefore, trace elements as indicators of contaminated rivers are available.

Key words trace element; rare-earth element; contaminated river; sewage discharge; Taihu Lake

The treatment of wastewaters with high phosphorous and high ammonia loadings using modified bauxite refinery residues

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Bauxsol(TM) is a trade marked name for a modified bauxite refining residue where Ca and Mg are used to transform carbonate and hydroxide alkalinity from soluble to insoluble forms within the bauxite refinery residue (red mud), This leads to a pH reduction from >13 to ≈8.5 and reduces soluble Al and Na contents. The concentration ratios of Ca and Mg in the treatment brine can be manipulated to provide neo-formational mineral assemblages dominated by either Mg, or Ca end members; hydrotalcite and brucite (Mg-rich), or hydrocalumite, para-aluminohydrocalcite, aragonite and portlandite (Ca-rich). The Bauxsol(TM) raw material (BRM) has excellent metal binding capacity (>1500 meq/kg), good P binding capacity (>2% by mass) and a good acid neutralising capacity (3.5-7 M/kg), however the BRM can be further blended with other mineral additives to enhance the geochemical properties and improve specific performance. This paper reports on the use of a high-Mg Bauxsol(TM) blend to treat waters that have high P, NH_4^+ and polyacrylamide (flocculant) loadings in Biological Nutrient Reduction (BNR) plant digested sewage sludge centrates. Initial analysis of the centrate indicated it contained 325 mg/L total-P (225 mg/L P as ortho-P), 767 mg/L N as NH_4^+, suspended solids loads (TSS) of 683 mg/L and chemical oxygen demand (COD) of 480 mg/L (although the day to day variability in nutrient loadings can be as much as 25%). This was then treated using 1.7 g/L of a high-Mg Bauxsol (TM) blend to yield a water with <1.8 mg/L total-P (ortho-P is <0.5 mg/L), NH_4^+ <460 mg/L N, <60 mg/L TSS, and <300 mg/L COD. Small additions of ferric chloride post Bauxsol (TM) addition reduced the soluble ortho-P load by about 50% and about 30% of the COD, but these additions appear largely unnecessary. Analysis of the solid residue indicates it contains 11.5% P, 0.39% N, 21% Mg, and 2.44% crude protein making the solid residue a potentially useful fertilizer. It is likely that P and NH_4^+ is affected by the formation of $MgHPO_4$ and $Mg(NH_4)PO_4$ (Struvite) within the solids. Calculations from the solids indicate that 85% of the P removal is as $MgHPO_4$, which appears consistent with literature on the formation geochemistry of struvite around pH 8.0. Further manipulation of the geochemistry of waters and kinetics of crystal growth may allow for a greater struvite recovery, and further enhanced ammonia removal. The treated centrate is then reported back to the head of works and solids are removed with the sludge at the primary and secondary clarifier. In addition, to the NH_4^+ removal as struvite the anecdotal evidence from the BNR plant operators suggests that these high-Mg Bauxsol (TM) blends have reduced polymer use in the centrifuges, reduced alum dosing rates for P removal at the tertiary clarifier, and eliminated hydrated-lime additions (an OH and S hazard) to maintain pH.

Key words sewage; nutrient; removal technology; Bauxsol (TM); waste utilization

Non-point source pollution of Wujiang River watershed in Guizhou Province, SW China

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The amount of pollution from non-point sources flowing in the streams of the Wujiang River watershed in Guizhou Province, SW China, is estimated by a GIS-based method using rainfall, surface runoff and land use data. A grid of cells, 100 m in size, is laid over the landscape. For each cell, mean annual surface runoff is estimated from rainfall and percent land use, and expected pollutant concentration is estimated from land use. The product of surface runoff and concentration gives expected pollutant loading from that cell. These loadings are accumulated going downstream to give expected annual pollutant loadings in streams and rivers. By dividing these accumulated loadings by the similarly accumulated mean annual surface runoff, the expected pollutant concentration from non-point sources is determined for each location in a stream or river. Observed pollutant concentrations in the watershed are averaged at each sample point and compared to the expected concentrations at the same locations determined from the grid cell model. In general, annual non-point source nutrient loadings in the Wujiang River watershed are seen to be predominantly from the