

Pollutant sources of groundwater in the Sichuan Basin, China

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INTRODUCTION

The Sichuan Basin is known as one of the most populated and heavily industrialized areas in China, and is facing to the serious environmental pollution. In this report, the sources of pollutants in the groundwater and their migrating paths along water circulation are discussed based on the sulfate and nitrate ions of the groundwaters from the source area and five large cities (Dujiangyan, Leshan, Yibin, Luzhou and Chongqing) along the Minjiang and Yangtze rivers in the basin.

RESULTS

The studied groundwaters are characterized by Ca-HCO₃ dominant chemistry. The samples from the source area and Dujiangyan were collected in March and September, 2003, and from other four places collected in March and September, 2004. Distinctive differences were generally not detected in the major chemistry of samples taken from the different periods, thus, data of sulfate and nitrate ions of groundwaters sampled in September are described in the following.

In the source area, 64% of 44 samples contained lower SO₄ than 10mg/L, and the maximum concentration was 61mg/L. 12 samples were higher than 1.0mg/L NO₃-N, and two samples were higher than 10mg/L. At Dujiangyan, located on the alluvial fan at the edge of the basin bottom, most of 66 samples had SO₄ and NO₃-N within the ranges of 20-60mg/L and 1.0-10mg/L, respectively. 15% of 66 samples had the NO₃-N higher than 10mg/L. At Leshan, 54% of 41 samples had SO₄ higher than 60mg/L. The highest one was 347mg/L. 22% of 41 samples were higher than 10mg/L NO₃-N. At Yibin, 71% of 34 samples had SO₄ higher than 60mg/L. The highest one was 332mg/L, which was taken near a sewage trench. Four samples contained higher than 10mg/L NO₃-N. At Luzhou, all the samples have SO₄ concentrations higher than 20mg/L, and 31% of 35 samples were higher than 100mg/L. In this area, two in March and one in September have the SO₄ concentrations higher than 250mg/L (the minimal for taste impairment suggested by WHO). 31% of 35 samples contained higher than 10mg/L NO₃-N. At Chongqing, all the samples had SO₄ concentrations higher than 30mg/L, and 62% of 34 samples were higher than 100mg/L. Three samples had the SO₄ concentrations higher than 250mg/L. NO₃-N higher than 10mg/L was contained in 13 samples.

DISCUSSIONS

The sulfate and nitrate concentrations of groundwater gradually increase from the source area toward the downstream of Minjiang River and Yangtze River. The groundwaters were not seriously polluted in the source area, except where local household waste water contaminated into the adjacent well water. While, highly SO₄ and NO₃-N containing groundwaters were constantly observed at Luzhou and the lowermost Chongqing. Those two components do not have a good linear correlation, suggesting of two or more sources of those pollutants.

The increase of sulfate and nitrate contents was occasionally consistent with that of chloride content, indicating that those three components would be originated from the household waste water, especially at Leshan and Yibin. Groundwaters would be polluted by industrial waste water containing organic menstruum, since bromide ions were often detected in spite of the low chloride concentrations, especially at Luzhou and Chongqing.

The sulfur isotopic values of sulfate ions range mainly within +1.0 - +5.5 per mil and are overlapping those of dissolved sulfate in rains and coals, which deduced that the sulfate mostly originated from air pollutants. Air pollution especially affects to the groundwaters of Dujiangyan. The moderate sulfur isotopic values ranging between +6.0 - +10.0 per mil indicated that these sulfates might result from household waste.