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Changchang Fu, Xiangquan Li, Jianfei Ma, Lingxia Liu, Ming Gao, Zhanxue Bai

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1 **A hydrochemistry and multi-isotopic study of groundwater origin and hydrochemical**
2 **evolution in the middle reaches of the Kuye River basin**

3 Changchang Fu^{1*}, Xiangquan Li¹, Jianfei Ma¹, Lingxia Liu¹, Ming Gao¹, Zhanxue Bai¹

4 1. Institute of Hydrogeology and Environmental Geology, Chinese Academy of Geological Sciences,
5 Shijiazhuang Hebei, 050061, China

6 *Corresponding author: Changchang Fu

7 E-mail: fu0936@163.com

8 **Abstract:** The Kuye River basin lays in an economically and ecologically important area, therefore,
9 the groundwater quality issues are of growing concern in this semi-arid region. In the present study,
10 the combination of techniques (i.e. piper diagram, ionic ratios, Gibbs diagrams, multiple isotopic
11 analyses etc.) provided an efficient way for analyzing the groundwater origin and hydrochemical
12 processes that affected water chemistry. The groundwater type was Ca-HCO₃ in low TDS values
13 and Na-Cl/SO₄ in high TDS values in both shallow unconfined and deep Cretaceous-Jurassic
14 semi-confined aquifer. And, furthermore, Na⁺, Cl⁻, SO₄²⁻ and F⁻ were the dominated parameters
15 deteriorating the groundwater quality. In general, groundwater was of meteoric origin and the more
16 depleted δ¹⁸O and δD features of CJY groundwater samples indicated that the groundwater was
17 formed during the wetter and colder climate. The rock weathering in conjunction with the cation
18 exchange absolutely predominated in geochemical evolution and deuterium excess method
19 quantified that mineral dissolution contributed most of the salinity (67-92%) of the groundwater.
20 The SO₄²⁻ of the groundwater was primary from the dissolution of sulfate minerals, next was the
21 atmospheric precipitation. In addition, bacterial sulfate reduction was an important reaction
22 affecting the SO₄²⁻ concentration in the groundwater from CJY aquifer. The hydrochemical type of
23 high fluoride groundwater in the study area was Na-HCO₃ or Na-Cl/SO₄ and it was mainly from the

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