Geophysical Research Abstracts
Vol. 20, EGU2018-3788-2, 2018
EGU General Assembly 2018
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Hydrogeochemical characteristics and quality assessment of groundwater in Wudaoxian map-area, Lanzhou New area, Northwest China

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Groundwater quality is a vital factor to human health and agricultural production safety in Wudaoxian map-area , a typical semi-humid and semi-arid area with saline-alkali soil. To explore the hydrogeochemical characteristics and evaluate the groundwater quality, a total of 44 groundwater samples were collected from the area. The hydrochemistry was assessed by a Piper diagram, groundwater hydrochemical characteristics and evolution processes was detected by multivariate statistics, ratios of major ions, saturation index calculations and Gibbs diagrams, and groundwater suitability for drinking and irrigation was evaluated by fuzzy membership analysis, some water quality indices and diagrams. The results show that the major cations of unconfined and confined groundwater both dominate with Na^{+}, Mg^{2+} and Ca^{2+}, while the major anions dominate with Cl^{-} and SO_4^{2-},and the concentration of major ions in the unconfined groundwater is rather high. The dominant hydrochemical facies of the groundwater in the study area is Cl-SO_4-Na type. According to the correlation analysis and principle component analysis, the sources of major ions in the groundwater may be the dissolution of mirabilite, halite and silicate. Ion exchange can also affects the groundwater constituents. Gibbs diagrams suggest that it is the strong evaporation and rock weathering dominate the formation process of groundwater chemical composition. In addition, human activities such as abuse of fertilizer are another avenue which can deteriorate the groundwater. The hydrochemistry of unconfined groundwater is mostly same with confined groundwater, which suggests the frequently hydraulic connection of the groundwater. As to the suitability of groundwater for drinking and irrigation, the unconfined groundwater samples are gathered into class III and V, while confined groundwater samples are grouped as class II, III and V by fuzzy membership analysis. Only one sample of unconfined groundwater is suitable for drinking, which suggests that the confined groundwater is relatively applicable for drink. A US Salinity Laboratory diagram shows that most samples belong to category C3-S1, C4-S2 and C4-S3.And Wilcox diagram shows that the percentage of permissible to doubtful, doubtful to unsuitable and unsuitable groundwater are 29.54%, 6.82% and 63.64% respectively. Some irrigation indices have been also proposed to estimate groundwater's suitability for irrigation purpose, which indicates that more than 60% of the groundwater samples are not suitable for agricultural irrigation. The major problem of the groundwater in the study area is sodium and salinity hazard, and integrated management of groundwater for drinking and irrigation is the way to solve the water issues.