Geophysical Research Abstracts
Vol. 20, EGU2018-2228, 2018
EGU General Assembly 2018

Groundwater evolution in Central Gangetic aquifer system and interaction with river Ganges in Varanasi, India

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Major controlling factors for solute composition in groundwater include chemistry of recharging water, sediment-water interaction and groundwater residence time. Processes responsible for solute chemistry evolution of groundwater for Central Gangetic Basin (CGB), are investigated through this study. The study was carried out in and around the ancient city of Varanasi residing at the bank of Ganges (Ganga) river, which acts as a major hydrological boundary and regional discharge zone between the Himalayan foreland basin aquifers and the Indian peninsular cratonic aquifers. River Ganges is mostly responsible for the fate of groundwater as well as the sediment in CGB. Bivariate mixing diagram of Na normalized Ca versus Na normalized HCO_3^- tend to fall within or close to the global average silicate weathering domain, suggesting incongruent leaching of argillaceous metamorphics and volcanics from Himalayas, and surrounding Precambrian (Lesser Himalayas and Indian Craton) and Mesozoic (Deccan-Rajmahal Trap) units along with other solute transfer mechanism that controls the solute chemistry of the groundwater in CGB. For silicate weathering to be the primary source of bivalent cations, predominance of Ca and Mg in bivariate plots of Ca+Mg and Na+K versus total cationic concentration suggests that the sediment provenance have to be dominated by alkaline earth silicates from Himalayas with a small percentage of carbonates from Paleozoic-Mesozoic and Precambrian cratonic units and Quarternary alluvium. Similar trends in stable isotopic signature during dry season clearly indicate interaction between groundwater and river water. Groundwater fraction getting mixed with the river water is found to be higher in the southern part of Varanasi. High resolution Ganges river water chemistry is also studied in order to delineate the groundwater-river water interaction.