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Geochemical evolution and reaction mechanisms controlling groundwater chemistry in the Pra Basin (Ghana)

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As the demand for water supply increases with population growth, the quality of ground and surface water resources is deteriorating rapidly in many regions worldwide, particularly in Ghana. This situation has put supply systems under severe pressure as many of the available water resources are polluted by anthropogenic activities such as mining, agriculture, domestic and industrial sewage. Ghana's water quality problems are not different from current global challenges, as many surface waters and some aquifers have been polluted by mining activities and to some extent also by agriculture and industrial seepage. The Pra Basin is one of the most affected basins in Ghana with a total area of around 2,300 km^2 and a population of over five million people. The economic history of the basin is unparalleled as it is home to the country's major mineral deposits, including gold, bauxite, manganese, and diamonds. Recent studies have shown significant amounts of water pollutants including mercury (Hg), arsenic (As), lead (Pb), iron (Fe), manganese (Mn), cadmium (Cd), selenium (Se) and nitrate (NO_3). The underlying geology of the Pra Basin consists mainly of metasediments and granitoids. The occurrence of groundwater is controlled by the development of secondary porosities through fractures, joints, and faults. This study provides insights into the evolution and hydrogeochemical processes that control the groundwater quality in the Pra Basin. The methodology applied here includes field sample collection, statistical analysis of hydrochemical data, petrographic and mineralogical analysis of rock outcrops and geochemical modelling. Groundwater samples were taken from shallow (mainly hand-dug wells with depths <10 m) and deep aquifers (mainly boreholes with depths >30 m) throughout the basin. Samples were analysed for major ions, and trace metals using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES), Ion Chromatography (IC), and a Picarro L-2140i Ringdown Spectrometer. Multivariate statistical analyses, inverse and forward geochemical modelling were applied to the hydrochemical data of around 100 water samples. The mineral phases used as model input were obtained from X-ray Diffraction (XRD) measurements of rock outcrops from the study area and mainly include chlorite, albite, muscovite, biotite, and calcite. The analysis of the results shows that the geochemistry of the groundwater resources in the Pra Basin is mainly controlled by water-rock-interaction. Within the given uncertainty limits, the dissolution of carbonates and weathering of silicates are the drivers for the chemical development of the groundwater in the basin. The presented findings will support the development of sustainable water resources management strategies and contribute to mitigating future

contamination.