ABSTRACT

Groundwater always contains some amount of chemical constituents and their concentration is a function of water, rainfall, land use, formation of rocks and recharge processes. Evaporation, deposition, dissolution and weathering of minerals, ion exchange is some of the common geochemical processes that occur in the groundwater system. Geochemical processes that are taking pace within the groundwater system due to the reactions with aquifer materials have a profound effect on water quality. The quality of groundwater is therefore dependent on the chemical and physical properties of aquifer formation. Detailed knowledge on geochemical process that control groundwater chemistry is very essential to understand and deal with the groundwater related issues. Even though there are several studies on hydrogeochemical processes in the arid region of alluvial and basaltic terrain no major research has been carried out in arid regions of granitic terrain. Implication of irrigation activity, evaporation, spatial, temporal variation and geochemical processes of granitic aquifers need to be understood. The granitic terrain of Archean age in the central southern India, is one such area with arid climate where irrigation is practiced. The aim of the present study is to understand the hydrogeology and hydrogeochemistry of the groundwater of a part of Nalgonda district, Andhra Pradesh, India. The major objectives of this study are to understand the hydrogeology of the area, identify the spatial and seasonal variation in major ion chemistry of groundwater, characterize
the groundwater geochemistry of the aquifer system and determine the hydrogeochemical processes that control the groundwater chemistry.

The study area forms a part of Nalgonda district, Andhra Pradesh, which is located at a distance of 85 km ESE of Hyderabad. The boundaries of the study area were delineated in such a way to have a watershed boundary as far as possible. The total area of the study region is 724 km$^2$. This area lies under the tropical region where with climate is characterized by arid to semi-arid climate. Topographically of the area is of an undulating terrain with a maximum elevation of 348 m on northwestern side and minimum elevation of 170 m on the eastern side. Geologically the study area comprises of granite and granitic gneiss. These rocks are generally medium to coarse-grained. These rocks are traversed by numerous dolerite dykes and quartz veins. The granitic rocks are intensely weathered and the thickness of weathered zone ranges from 4 to 15 m. Calcareous material like calcrete was observed in the weathered zone of several large diameter wells. In certain regions calcrete was also observed in ground surface and rock exposures.

The rocks are highly weathered generally up to a depth of 15 m from the ground surface. These rocks are traversed by numerous dolerite dykes and quartz veins which are well exposed in most parts of the area. These dykes are not functioning as a subsurface barrier to groundwater flow due to the high intensity of weathering. The resistance of the subsurface strata was measured and the values obtained were interpreted to understand the lithological variation. In general 0 to 3m below ground surface comprises of
top soil, 3 to 13m comprises of highly weathered rock and the moderately weathered is found after 13 to 30m.

The pH of the groundwater of this area is slightly alkaline in nature. The EC of the groundwater samples increases towards southeastern side of the area. Reasonably high Eh values indicate that the groundwater is oxidized state. The general order of dominance of cations in the groundwater of the study area is $\text{Na}^+ > \text{Ca}^{2+} > \text{Mg}^{2+} > \text{K}^+$ while that for anions it is $\text{HCO}_3^- > \text{SO}_4^{2-} > \text{Cl}^-$. There are two types of seasonal variations in groundwater ionic concentrations are found in this study area. The first type of variation occurs during the rainfall recharge as the concentration of ions decreases in groundwater and the water level increases. The spatial variations of all major ions are more are less similar but the pattern of bicarbonate variation is of slightly different. High concentration of most of the ions in the south eastern part of the area is mainly due to the occurrence of shale interclation with quartzite. Low concentration of major ions is observed in the central part and southwestern part of the study area due to comparatively higher rainfall recharge. Comparatively high TDS in groundwater was found in the southwest of the study area. This is due to the presence of shale formation in this part of the area. The groundwater classification is based on total hardness represent the majority of samples fall under hard and very hard category. Quality of irrigation water based on electrical conductivity the 80% of samples falls in permissible limits.

The major geochemical processes controlling the major ion chemistry of the groundwater are evaporation, ion exchange, silicate
weathering and dissolution of minerals. Weathering and dissolution of silicate minerals control the concentration of major ions such as Na\(^+\), Ca\(^{2+}\), Mg\(^{2+}\) and K\(^+\) in groundwater of this area. Ion exchange process also controls the concentration of Ca\(^{2+}\) and Na\(^+\). Relation between groundwater level and saturation index of minerals reveals the importance of evaporation process on groundwater ionic concentration and irrigation practice in this arid region.

Even though the groundwater occurs in granitic formation, geochemically many groundwater samples collected are over saturated with respect to calcite and dolomite. Aas the carbonates are likely to be derived from Rhodustalfs. Thus this work has demonstrated the significance of hydrogeochemical studies in understanding the variation in groundwater chemistry and helped in the identification of hydrogeochemical processes in this hard rock region.

This will form a base line study as it is proposed to mine the uraninite present in the unconformity between the cuddapah and archean formation of this region. Identified geochemical process will serve as background information and will help to know if there are any changes in groundwater environment in future due to the proposed mining and milling activity in this area. Further, the hydrogeological and hydrochemical studies formed a basis for carrying out the numerical and hydrogeochemical modelling to understand effect proposed uranium tailings pond on groundwater environment in this area.