

## Proofread Version

Master Science Thesis\_Hydrogeology

Gibbs (1970) identified ~~the~~ three major mechanisms that controlling 'surface water' chemistry; ~~defined as~~ atmospheric precipitation, rock-water interactions and evaporation-crystallization ~~process~~. The author identified that the major cations characterizing the end members of the world's surface waters are Ca for freshwater and Na for highly saline water bodies. In the Gibbs Plot (Figure...), the weight ratio of the cations  $\text{Na}/(\text{Na}+\text{Ca})$  (Gibbs ratio I) is plotted on the x-axis and Total Dissolved Solids (TDS) on the y-axis. A similar plot ~~is created with for~~ the anions  $\text{Cl}/(\text{Cl}+\text{HCO}_3)$  (Gibbs ratio II) ~~are plotted~~ on the x-axis and TDS on the y-axis. The Gibbs Plot has since been used in groundwater hydrogeochemistry; to determine the processes that controlling the composition/addition of dissolved salts to groundwater.

Marandi and Shand (2018) assessed the correctness ~~in of~~ applying the Gibbs Plot to 'groundwater' studies and remarked that it is not incorrect to do so. In fact, plotting ion ratios and salinity of groundwater can lead to a better understanding of key hydrochemical processes. Furthermore, according to Alley et al. (1998; as cited in Marandi & Shand, 2018), two-thirds of stream flow around the world is groundwater that has been discharged into streams ~~(Alley et al., 1998 as cited in Marandi and Shand, 2018)~~. Marandi and Shand ~~The authors'~~ further state that the incorrect use of the Gibbs Plot occurs when groundwater studies analyse process-based models that have been developed for surface waters and link these to the Gibbs Plot to assess groundwater processes. In doing conducting these kinds of analyses, interpretations of data is slowed down. Additionally, use of the Gibbs Plot used on its own in isolation oversimplifies and leaves out many other important processes that affect the chemistry of groundwater.

\_\_\_\_\_ Applying the Gibbs Plot to this study, values for groundwater samples in the study area range from 0 to 1.0 meq/l on the Gibbs ratio I plot, with an average of 0.7 meq/l. Gibbs ratio II values for the same samples also ~~range~~ from 0 to 1.0 meq/l, with an average of 0.1 meq/l. All the groundwater samples plot in the middle section of the Gibbs Plots, suggestive of rock dominance as the main control of the groundwater chemistry in the area of study.

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