

## **Geochemical Influences on Sri Lankan Bottled Water**

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### **Introduction**

Sri Lanka is one of the renowned countries to have abundant sources of clean natural water resources. There are numerous discovered or undiscovered natural water bodies that contain clean water which can be used as drinking water without any treatment. They can be categorized according to the origin as artesian water, spring water, well water, prepared water or surface water. However, currently Sri Lanka is experiencing an unprecedented development which does not assure clean natural water anymore. At this scenario, bottled water plays a major role as a source of clean drinking water. Bottled water, which is used for human consumption may contain minerals and carbon dioxide, naturally occurring or intentionally added; but shall not contain added sugars, sweeteners, flavorings or other foods that are packaged in plastic or glass bottles and sizes range from small PET bottles to large gallons.

There are number of bottled water brands which contain treated or untreated spring water, well water, or river water which are bottled and distributed in various districts. This bottled water may contain different chemical components according to their natural source, different treatment methods or with the requirements. A research on investigating the chemical composition and its relationship with the bed rock geochemistry of the source area has not been conducted in Sri Lanka. Thus, this research aims at assessing the geochemical conditions of Sri Lanka's bottle water sources by analyzing samples collected from different areas of the country. Where the sources of bottled water are dug wells, springs or tube wells they can easily be used for the groundwater monitoring purposes.

It is attempted to recognize the real quality of the bottled water and to evaluate the quality compliance with the standards. In Sri Lanka there are two specific standards given for the bottle water by the Sri Lankan Standards Institution. Those are SLS 1038:2003 and SLS 894:2003 which define the requirements for high quality bottled water product.

### **Materials and Methods**

32 bottle water samples were selected distributed within 13 districts for the analysis from a list of 87 manufactures [2]. 19 chemical components were analyzed using various analytical methods. Major and minor ions were measured using titrimetric, spectroscopic methods such as atomic absorption spectrometer and UV/Visible spectrophotometer. Other physical properties were measured with standard electrodes. Chemistry of samples were further analyzed and manipulated with water quality modeling software such as Phreeqcl and Visual MINTEQ.

### **Results and discussion**

Measured water quality is summarized in Table 1. With the major cation and anion content; water samples can be divided in to 9 types of water. According to the bottle water samples and groundwater samples the analyzed samples belong to only 7 types of water (Figure 1).The groundwater contained different types of minerals and ions. These minerals are

dissolved, precipitated or in equilibrium with the water depending on the physicochemical conditions. Saturation Index of the minerals was used to understand the mineral content of water samples. With the analysis of visual MINTEQ software it was identified that nine minerals were at the over saturation state for all the water samples. Except that all the other 60 minerals were in under saturation state in water samples that was analyzed. And there was no any mineral at the apparent equilibrium state with the collected bottle or ground water samples.

### Conclusions

It can be concluded that most of bottled water follow the SLS guidelines. Various treatment methods and chemicals added through the bottle water manufacturing process can affect the chemical composition from time of production to expiry. Therefore, before commissioning bottled water production industry manufactures must obtain a proper idea on the groundwater conditions and its suitability for the drinking purposes.

Ferrihydrite, Goethite, Hematite, Lepidocrocite, Maghemite, Magnesioferrite minerals were at the over saturation state or precipitate in the water due to high concentration or high reaction rate.

Table 1. Chemical properties of bottled water samples

Parameter	Maximum	Minimum	Mean
pH	7.883	4.760	6.642
TDS (mg/L)	284.000	9.600	54.140
Conductivity (uS/cm)	582.000	19.660	109.823
Total Hardness (mg/L)	341.987	1.590	39.681
Na (mg/L)	15.990	0.375	4.279
K (mg/L)	3.927	0.069	0.967
Mg (mg/L)	76.500	0.101	6.643
Ca (mg/L)	25.741	0.094	4.841
HCO <sub>3</sub> <sup>-</sup> (mg/L)	73.200	2.440	21.987
SO <sub>4</sub> <sup>-2</sup> (mg/L)	13.152	3.329	7.813
Cl <sup>-</sup> (mg/L)	20.002	1.001	2.502
NO <sub>3</sub> (mg/L)	31.632	0.026	4.318
F (mg/L)	1.565	0.788	1.255
Residual Cl <sub>2</sub> (mg/L)	0.296	0.080	0.226
Fe (mg/L)	0.276	0.122	0.192
Mn (mg/L)	0.065	0.001	0.016
Zn (mg/L)	0.857	0.000	0.022

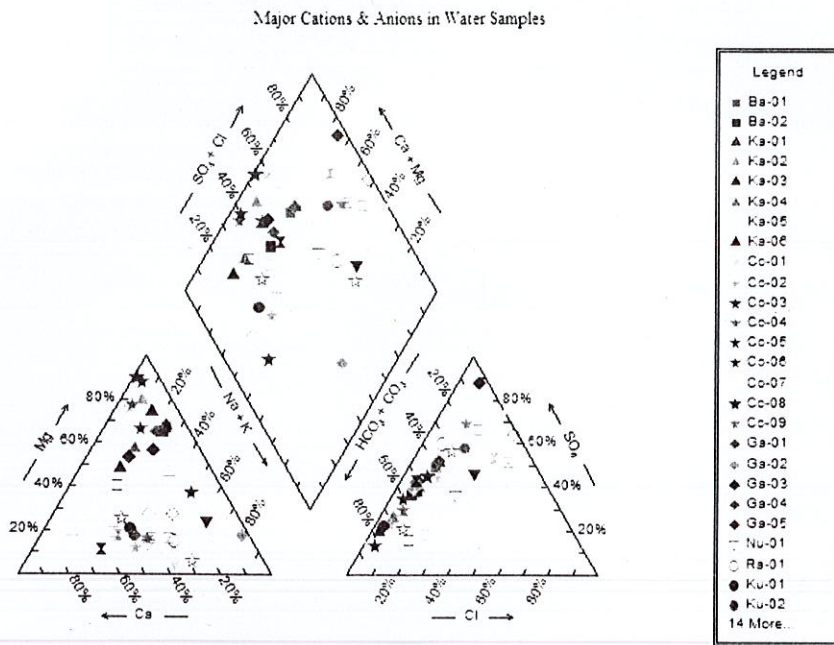


Figure 1. Piper diagram showing major ion water quality

### References

Specification for Bottled Natural Mineral Water, Second Revision, 2003.

Food Control Administration Unit. List of Names of Bottle Water Manufactures Brand Names and the Registration Numbers. Updated On 05 April, 2012.