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Surface and ground water chemistry in the vicinity of Lake Nyos

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In the process to achieve overall objective within the SATREPS Cameroon Projects, whose general topic is "Magmatic Fluid Supply into Lakes Nyos and Monoun and Mitigation of Natural Disasters through Capacity Building in Cameroon", an investigation with the assessment of groundwater-surface water system was carried out in the vicinity of Lake Nyos.

On the field, sampling campaign was conducted in January and December 2011. During the survey, 45 water samples were collected from 27 sites. At each sample site, on-site measurements of electrical conductivity (EC), pH, oxidation-reduction potential (ORP), and alkalinity were carried out. The EC value of spring and stream water samples in the watershed other than Nyos Lake were less than 8 mS/m, and some of them are even less than 2 mS/m. Whereas, the stream waters in the watershed of Lake Nyos show high EC values, which were over 10 mS/m. Water sources with low EC values may have no influence from neither the carbonate-rich lake Nyos water nor magmatic carbonate.

The chemical composition of waters in this area is far different from those in other volcanic areas. Bicarbonate is exclusively dominant among anions with very low concentration of chloride < 2 mg/L, and almost no sulfate, which shows only little contribution of air-borne sea-salt and lack of sulfuric sources in this area. For cation and silicon, which are the major rock constituent, the concentration of magnesium is secondary dominant to silicon, and calcium or sodium is relatively low.

Those analytical data set was subjected to multivariate statistical analysis to understand the geochemical potential factors affecting the chemical composition. The variation of major elements was compressed by principal component analysis (PCA) into three principal components. Using thermodynamic calculation, those components were interpreted; the first component was interpreted as silicate dissolution with 50 percent proportionate contribution of all chemical variances. The second component was moderately contributed by Cl and NO3, which was understood as influence of anthropogenic activity or inhabitation of fauna. The third component was understood as iron and magnesium dissolution by carbonic acid under reduced environment. The atmospheric sea-salt influence or hydrothermal contribution was statistically negligible.

The PCA scores of each sample clearly classified the samples into highly carbonate-influenced and non carbonate-influenced waters. The combination between PCA scores and pH-ORP diagram shows that the chemical behavior of dissolved iron and manganese are strongly influenced not only by carbonate concentration but also by pH-ORP conditions. The combination between PCA scores and thermodynamic stoichiometric calculation based on water-rock interaction introduced the theoretical equation "[Si] = 2[Na+] + 1/2 [Mg2+]". This equation fitted well to the analytical data and successfully demonstrated the water chemistry in this area.