TITLE: Hydrogeochemical mechanisms driving the occurrence of elevated fluoride contents of crystalline aquifer in Benin, Western Africa

AUTHORS : Joël Tossou, Philippe Orban, Moussa Boukari & Brouyère Serge

TOPIC: Theme 2. Multidisciplinary Approach to Safeguard Groundwater Quality
Sub theme 2.2. Groundwater related diseases and public health risks

KEYWORDS: fluoride, groundwater, crystalline aquifer, Benin.

Elevated concentrations of fluoride in drinking water is the source of severe healthy problems such as dental or skeletal fluorosis. High concentrations of fluoride are often observed in fractured and altered crystalline aquifers around the world. However, the hydrogeochemical mechanisms leading to such elevated fluoride concentrations are usually not fully understood. In particular, it is important to make the link between these elevated concentrations and the geological context in order to make efficient recommendations on appropriate locations of further groundwater abstraction wells.

This is the case in Benin, Western Africa, where groundwater from crystalline bed-rock aquifers is the main source for drinking-water supply. In this context, this research aims to identify the hydrogeochemical processes governing groundwater mineralization and the origin of the high fluoride concentrations. The investigations are based on groundwater samples collected in the central part of the country (Department of Collines), characterized by hard Precambrian aquifers. The hydrogeological system consists of a thin altered bedrock layer (shallow aquifer) and a deeper fractured crystalline bedrock (deep aquifer). The most significant groundwater quality problems in the area relate to the high fluoride (more than 7 mg / l) and nitrate (over 400 mg / l) concentrations in groundwater.

The collected hydrogeochemical dataset was explored using geochemical approaches and multivariate statistics. The results reveal that the water mineralization derives from hydrolysis of silicate minerals, but it is also influenced by anthropogenic effects, particularly in the shallow reservoir. However, fluoride has a natural origin, essentially related to weathering of silicate minerals, mainly from biotite. Ion exchanges between groundwater and the rock matrix also contributes to increase fluoride concentrations in groundwater. Earlier saturation of water with calcite and the precipitation of this mineral due to bicarbonate excess reduce calcium activity are favorable of the release of fluoride by rocks. Further investigations are going on to make the link between crystalline rock types, associated primary minerals and fluoride concentrations in order to identify the geological contexts which are more prone to such problems.