

The occurrence of fluoride in South African groundwater: A water quality and health problem

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Abstract

Groundwater is the most appropriate and widely used source of drinking water for many rural communities in South Africa. Pilot studies and surveys conducted by the Department of Water Affairs and Forestry (DWAF) indicated that there are a number of boreholes across the country that contain apart from fluoride, levels of nitrate, some heavy metals, total dissolved solids, sulphates and faecal coliforms (in some regions) that could pose a health risk if the water is used for drinking purposes. Very few boreholes have been tested for heavy metals or toxic organic substances. However, considering the levels of fluoride, in general, groundwater is of acceptable quality except for some areas in which elevated levels of natural groundwater fluoride occur. The study on which this paper is based was conducted to identify areas of high groundwater fluoride concentration in South Africa and to relate this to the occurrence of dental fluorosis in most communities using the groundwater for domestic use. Two sets of data were used. The fluoride data were obtained by extracting fluoride groundwater quality data from DWAF's Water Management Systems (WMS) database. STATISTICA and ARCVIEW were used to process the data. The dental fluorosis data were obtained from a field study conducted by the Department of Health. The degree of dental fluorosis was determined using Dean's classification criteria for dental fluorosis. The occurrence of dental fluorosis was observed in those areas in which fluoride levels were higher than the recommended guidelines for drinking water. The degree and severity of mottling in the subjects studied by the DOH team, corresponded with the level of fluoride in drinking water and the percentage morbidity of dental fluorosis varied from province to province, district to district and village to village.

Keywords: fluoride concentration; groundwater; fluorides; dental fluorosis; morbidity of dental fluorosis

Introduction

The beneficial attributes of fluorides to human health have been known for many years (WHO, 1970). When ingested at specific doses, the fluoride ion is beneficial to both bone and dental development in human beings. At correct intake levels it plays a very important role in the formation of teeth (Pontius, 1991). Too low fluoride intake levels during childhood may give rise to the occurrence of preventable dental caries in later years. Dental caries is a disease caused by specific bacteria harboured in dental plaque, fermenting carbohydrates to produce acids that can demineralise tooth enamel (Hammer, 1986). If this demineralization is allowed to continue, the enamel is penetrated permitting bacterial invasion and eventual loss of the tooth by decay in the absence of restorative dental care.

Too high fluoride intake normally gives rise to teeth mottling (dental fluorosis) and related problems. Chronic endemic fluorosis is a condition which is caused by an excess of fluorides in drinking water and which affects the calcification of the teeth, resulting in what is commonly known as dental fluorosis. Maughan-Brown in 1935 and Raubenheimer in 1938 first reported a study of the occurrence of mottled enamel in South Africa (WRC, 2001). In 1941, Ockerse produced three reports on human fluorosis in various regions of the former Union of South Africa. At that time 805 areas in which dental fluorosis occurred were known (Ockerse, 1947). The

majority of dental fluorosis sufferers (mainly blacks) in South Africa live in rural areas. Different studies have shown that the occurrence of dental fluorosis in the majority of cases in South Africa are related to the fluoride content of groundwater used for drinking purposes (McCaffrey 1993; Fayazi, 1994; Du Plessis, 1995; WRC, 2001).

The issue of whether and at what levels of concentration, to manage the fluoride ion concentrations in South Africa's public water supplies is a contentious one. While the Department of Water Affairs and Forestry (DWAF), as the custodian of the country's water resources, manages the fluoride levels through the criteria set in its guidelines, (DWAF, 1996) and the South African Bureau of Standards (SABS) determines the specifications (SABS, 2001), the Department of Health proposes compulsory fluoridation of public water supplies (Anon, 1998). Similarly, the awareness of excess fluoride consumption through water has been increasing country-wide. (McCaffrey, 1993; Fayazi, 1994; Rudolph et al., 1995; Du Plessis, 1995; WRC, 2001).

One of the main issues is the lack of adequate information on the environmental and health impacts of fluoride locally. Most of the information is highly technical for the local people and no proper interventions have been made to increase awareness. Most of the environmental issues are addressed in a recent Water Research Commission report (WRC, 2004). There is also a lack of accurate information in a user-friendly format about the current status of fluoride in the country's groundwater resources. This paper addresses these gaps by assessing the groundwater fluoride data from the Water Management System Database housed at DWAF's Resource Quality Services Directorate, for the period 1996 to 2000 in order to establish the current occurrence of fluoride ion concentration levels in groundwater sources and the impact of dietary fluoride (from groundwater consumption) on dental health. As

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