



A study of the sources, human health implications and low cost treatment options of iron rich groundwater in the northeastern coastal areas of KwaZulu-Natal, South Africa

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ABSTRACT

The groundwater of the northeastern coastal region of KwaZulu-Natal province of South Africa is characterized by high iron content. When the iron rich groundwater is pumped out to the surface, the water forms a precipitate of solid Fe-oxyhydroxide giving the water a cloudy reddish color. This condition is caused by the interaction of Fe^{2+} in the groundwater with atmospheric oxygen. Since this water is unfit for many purposes including domestic use, the local community's water supply is being highly affected. An investigation was undertaken to identify the source of high iron within the Zululand plain groundwater system, the health implications and affordable treatment options in order to make the water suitable for use. The results of the investigation show that the concentration of iron in the groundwater reaches 13 mg/L. The measured groundwater EC ranges from 124 to 1060 $\mu\text{S}/\text{cm}$, pH ranges from 5 to 8 and redox potential (Eh) ranges from +87 to −89 mV indicating both local oxidizing and reducing conditions. The results further show that the groundwater in the area is a fresh water system dominated by a Na–Cl hydrochemical facies indicating strong maritime influences. High iron concentration in water increases growth of unwanted bacteria forming slimy coatings in water pipes and when consumed excessively, it can lead to the build-up of iron in the body resulting into iron stores (high serum ferritin) which may be linked to diseases such as diabetes, heart disease, cancer and kidney problems. High residual content of iron in drinking water is also responsible for the unaesthetic nature of the water such as the metallic taste, discoloration and unpleasant smell of the water. Anaerobic groundwater conditions and the pH range observed during the investigation along with the presence of ferrirete and pyrite rich layers are responsible for the high concentrations of iron (II). An affordable groundwater treatment method based on aeration is recommended in order to safeguard community health, avoid expensive alternative water supply schemes and improve the negative perceptions of communities towards groundwater.

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1. Introduction

Groundwater accounts for about 30% of the entire world's freshwater and has been exploited and relied upon for domestic, livestock and irrigation uses for centuries (Kemper, 2004); and two thirds of the South African population depend on groundwater for their domestic supply (WRC, 2011). Similarly, the local communities in the northeastern coastal areas of the province of KwaZulu-Natal in South Africa depend mainly on groundwater for their water supply. The groundwater in this region is characterized by high iron content. When this iron rich groundwater is pumped out to the surface, the water forms a precipitate of solid iron-oxyhydroxide giving the water a cloudy reddish color, a condition which is caused by the interaction of Fe (II)-rich groundwater with atmospheric oxygen (Vance, 1994). The precipitation of iron-oxyhydroxide in the water is because of the fact that a reduced soluble divalent ferrous iron (Fe^{2+}) is oxidized to an insoluble trivalent ferric iron (Fe^{3+}) (Appelo and Postma, 1993; Deutsch, 1997). Since this iron rich water is

unfit for many purposes including domestic use, the local community's water supply is being highly affected.

Iron is an essential ingredient for the growth of humans, animals and plants and is a common constituent in soil and groundwater (Vance, 1994). However, high concentrations of iron in water increases growth of bacteria forming slimy coatings in water pipes, and when consumed excessively by humans, it can lead to the build-up of iron in the body resulting in iron stores (high serum ferritin) which may be linked to diseases such as diabetes, heart disease, cancer and kidney problems (Water Stewardship Protection, 2007).

An investigation was undertaken to identify the main source of iron in the groundwater system of the northeastern coastal areas of South Africa, the health implications and affordable treatment options of this high iron containing groundwater in order to make the water suitable for use.

1.1. Location of the study area

The study area covers the catchment area of Lake Sibayi, situated on the Maputaland coastal plain in northern KwaZulu-Natal (Fig. 1). The

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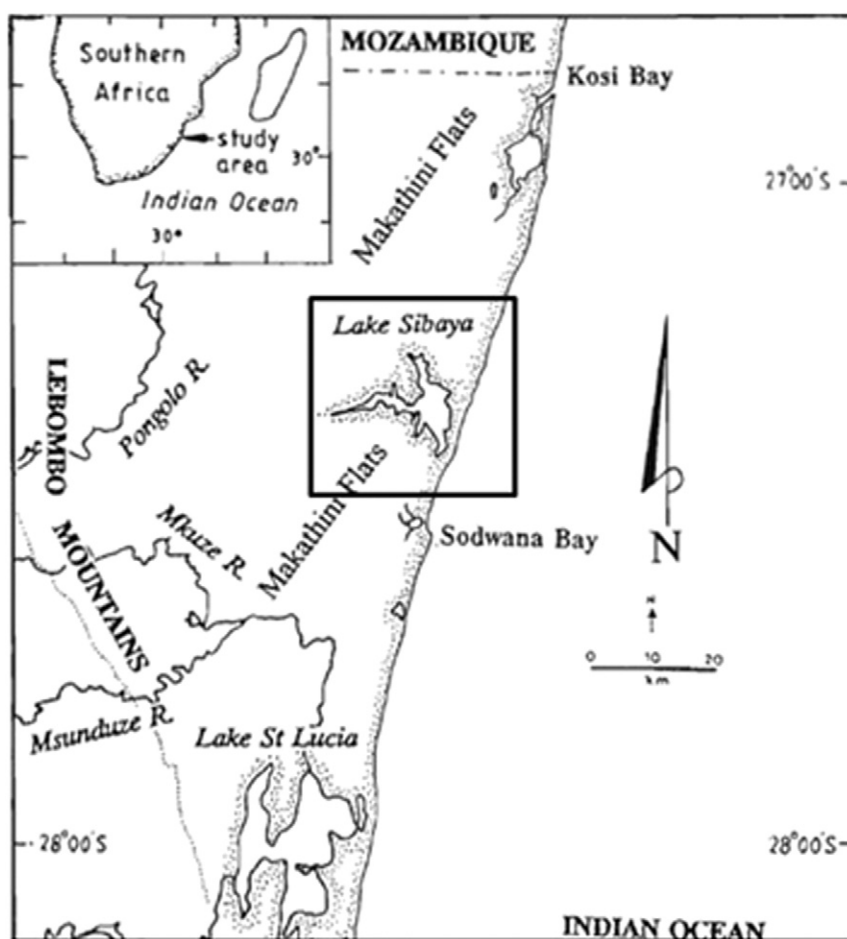


Fig. 1. Regional map of the KwaZulu-Natal coastal plain showing the study area (modified after Miller, 1998).

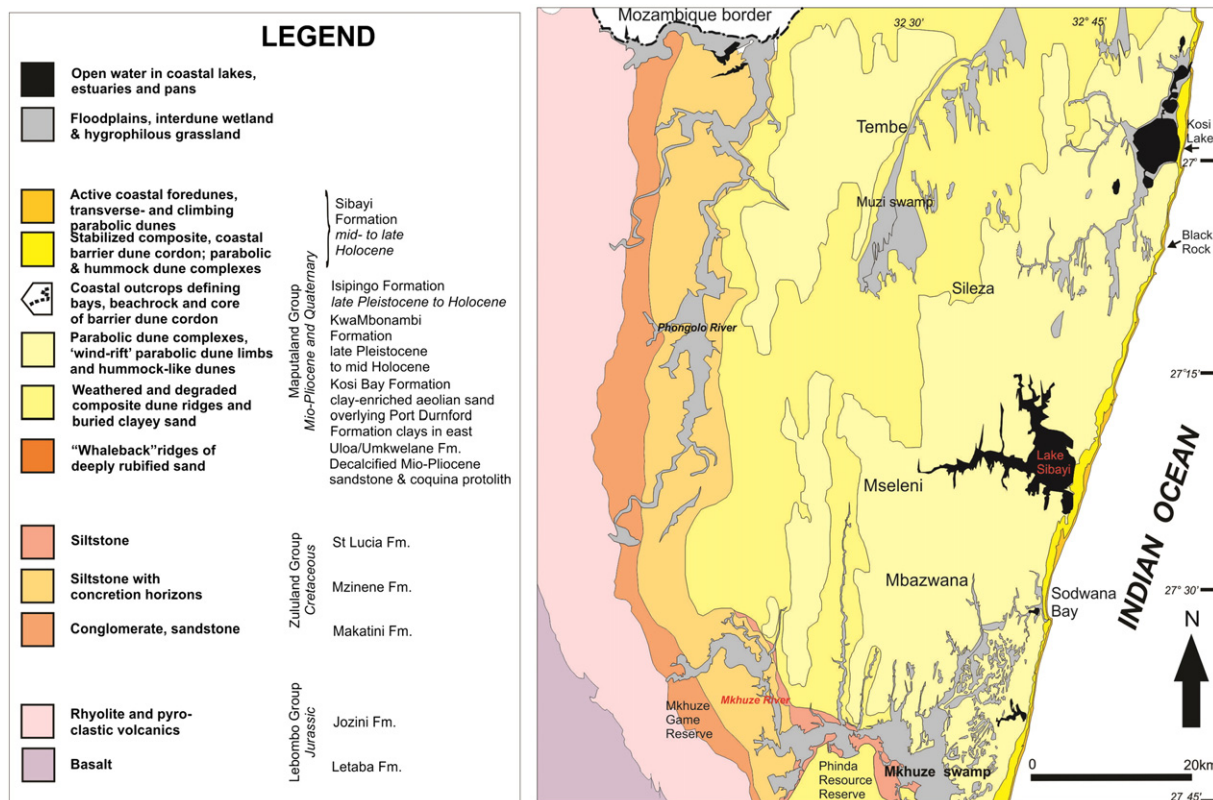


Fig. 2. Regional geology of the study area (modified from Porat and Botha, 2008).

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