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Selenium status in environmental samples and South African food products: A review

Introduction

Selenium (Se) is an essential micronutrient for all forms of animal life that have nervous systems. Its biological activity is achieved by its compounds and complexes. In nature, Se enters mammalian systems mainly as selenite or selenomethionine, which subsequently becomes metabolized to various derivatives. Dietary Se acts primarily as selenoproteins that are responsible for metabolic processes through allocation at active sites of the enzyme Glutathione peroxidases. High Se concentrations in mammals are toxic, whereas very low concentrations result in a chronic and sometimes fatal deficiency[1].

Over the past years, determination of the total analyte concentration has been used. However, the total concentration data is not adequate to provide a suitable understanding of the analyte behaviour and transformation in the environment. [2].

Se enters the food chain through the metabolic transformation from soil to plants. In biological systems it acts as an antioxidant, regulates thyroid hormone metabolism and facilitates cell growth. In many parts of the world, selenium concentration is very low in the soil, resulting in severe disease in domestic livestock, which has also been observed in humans [3].

The National Metrology Institute of South Africa is expanding its capabilities in the analysis of trace and ultra-trace levels of toxic and minor elements as well as organometallic species in environmental samples to support University of Pretoria projects in the field of veterinary geology for the One Health Platform. This project focuses on a life cycle study for selenium in parts of South Africa(SA), e.g. the Northern Cape, to determine possible causes of low levels of selenium in the livestock, which has detrimental health effects on the animals. This paper presents a review of the state of our knowledge of total selenium and selenium speciation analysis in SA.

Literature review

SA has a long history of selenium deficient soils, although detailed data regarding the Se content in soils are limited. Most Se studies in SA are top-down approaches, which use Se concentration in animal/human tissue as bioindicators for Se availability in soils. Whole blood Se in sheep of the Natal Midlands, was found to be 0.54 ± 0.20 µmol/L, 67 % of the sheep were Se deficient[4]. In another study for grazing herbivores, KwaZulu Natal and Western Cape were reported to be deficient at less than 50 ng/g whole blood Se concentration, However, in the same study cases of adequate Se were reported for the Eastern Cape and Western Cape (80 to 200 ng/g). [5].

Se concentration in maize from different silos in SA were quantified, 94% of the maize was found to be Se deficient [6] . The low Se concentrations in animal tissue and food products badly affect the Se status in humans, a total of 62.2 % of people from tribal and informal settlements are badly affected by low Se intake, with 60 % being children between the age 1 to 9 years [7]. Though statistics shows Se deficiency in mammals, there are parts of SA known to be Se hotspots, as shown in **Figure 1**. are several factors that contribute to the Se status in South African soil

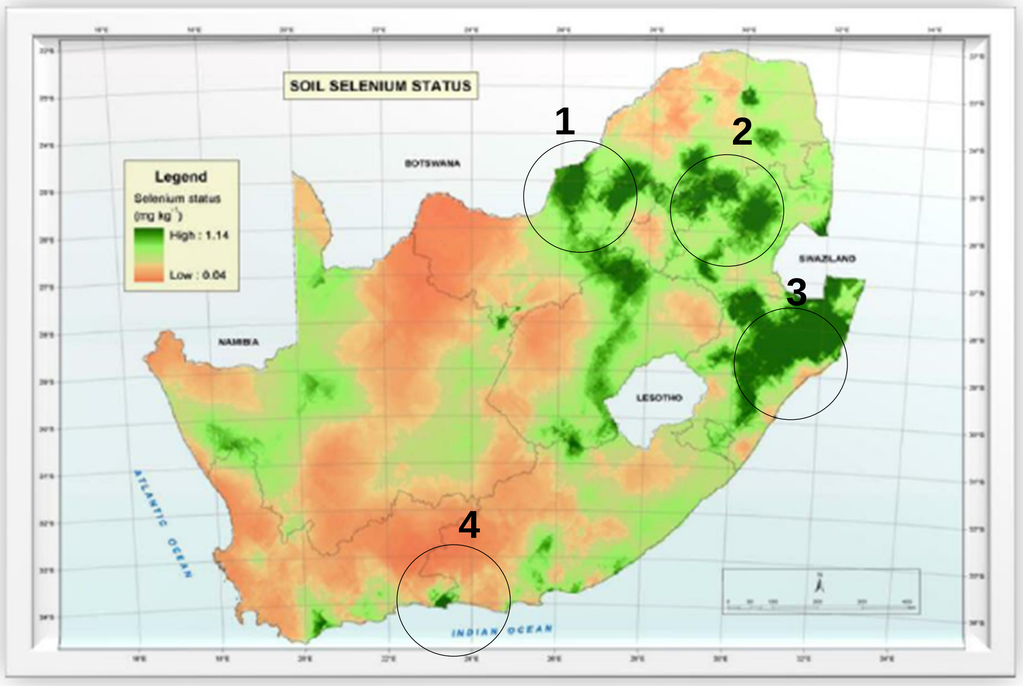

Figure 1 : Map of soil selenium status (mg/kg) in South Africa [8].

Amongst all the contributing factors, it is known that, the underlying geology has more influence, in total Se concentration in soil [9] . **Figure 1** shows the distribution of Se in SA soils and **Figure 2** is the simplified South African Geology Map. When correlation the two maps the observations recorded in **Table 1** can be made

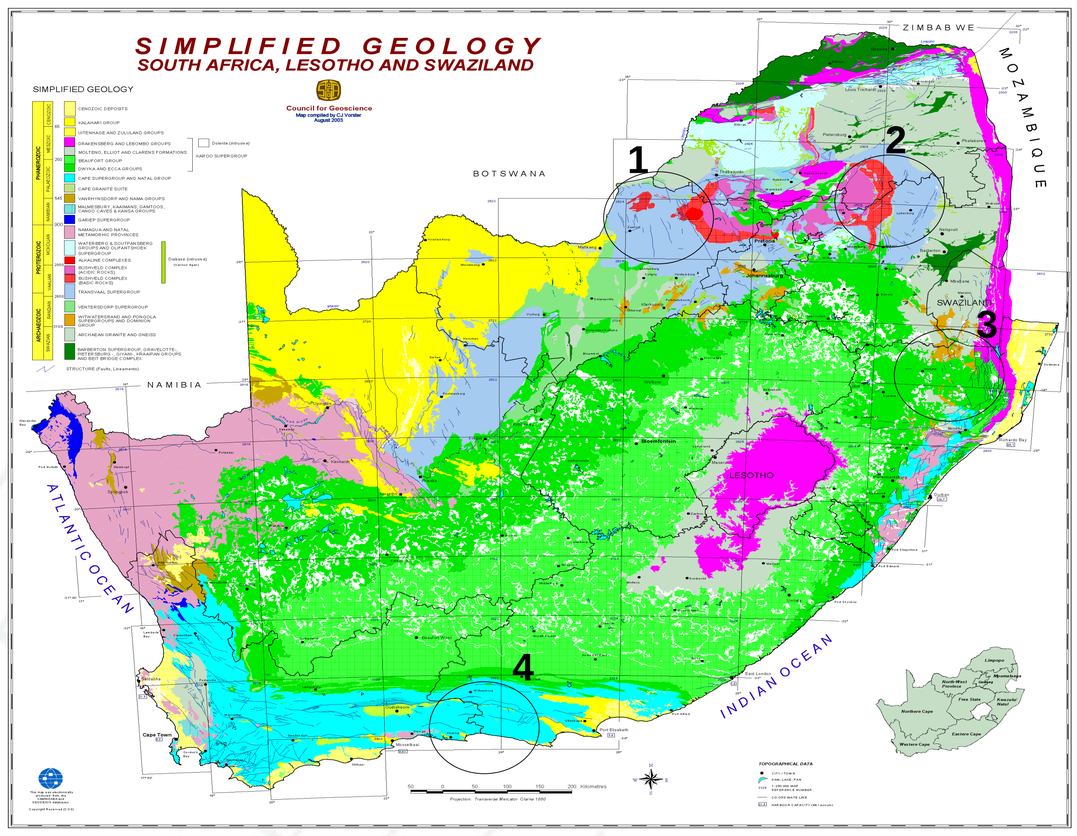

Figure 2 : Simplified geology of South Africa [10].

Table 1: Comparison between Se distribution in soil and underlaying geology [11]

Area	Geological classification	Dominant Rock type
1	Transvaal Super group (Kanye Basin)	Sedimentary
2	Transvaal Super group	
3	Karoo Basin (Dwayka group and Ecca group)	
4	Cape Super group (Witterberg) group	

- ❑ The observation are in agreement with other literature studies , which indicate that sedimentary rocks have more Se content[12].

Conclusion

- ❑ South Africa has a low dietary Se intake and is largely dominated by Se deficient soils.
- ❑ Limited data on concentration of total Se and Se species in South African soils, plants and food requires;
- ❑ development and validation of robust analytical methods & techniques for separation & detection.
- ❑ studying the transformation of Se from soils, plant and food products.
- ❑ establishing the root cause of the low concentration of Se in South African soils, more especial in Se hot spots

Se studies will lead to risk maps for South Africa, which will be useful to plan necessary interventions in the respective areas

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