Bull. Environ. Contam. Toxicol. (2002) 69:638–643

DOI: 10.1007/s00128-002-0108-4

Bulletin of Environmental Contamination and Toxicology

Zinc in the Surface Soil and Cassava Crop in the Vicinity of an Alluvial Goldmine at Dunkwa-on-Offin, Ghana

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Received: 12 April 2002/Accepted: 5 August 2002

Ghana is well endowed with diverse mineral resources. The major ones are gold, diamond, manganese dioxide and bauxite. Gold the predominant mineral produced in Ghana has been mined and exported for over a century (Hugg 1989). At Dunkwa-on-Offin gold occurs as free gold in alluvial sand and gravels (Vasilind et al 1993). The recovery process involves underwater excavation of placer deposits by bucket ladders transportation of under size particles, amalgamation with mercury and recovery of gold for further treatment. The metal may be leached with dilute sodium cyanide solution and the filtrate treated with zinc dust to precipitate gold. The molten material may be reduced with HCl to give gold bullion which is about 90-95% rich in gold. Thus in the environment of an alluvial goldmine mercury and zinc may be present as contaminants.

The present report is part of the studies to find the distribution of zinc and mercury near an alluvial gold mine and in the country in general.

MATERIALS AND METHODS

Twenty-three farms located within the vicinity of Dunkwa-on-Offin in various directions, Figure 1, were selected. At each sampling site three subsites were located randomly. Soil samples were collected by removing the top litter first and a teflon-coated soil auger was used to collect the samples. The samples were collected at depths of 0-5, 5-15 and 15-30 cm to cover the plough zone. The samples were put into already well washed plastic containers and sealed. Nine soil samples were collected from each farm. The auger was washed with distilled water after sampling at each subsite to avoid cross contamination. Identification numbers and labels were made on each plastic container and conveyed into the laboratory.

Cassava tubers were uprooted by first scrapping off the top soil with a steel cutlass from three different plants selected at random. The tuber was cut off from the stem and the adherent soil removed and put into separate poly ethylene bags and sealed. Cassava leaves were clipped with the fingers in rubber gloves

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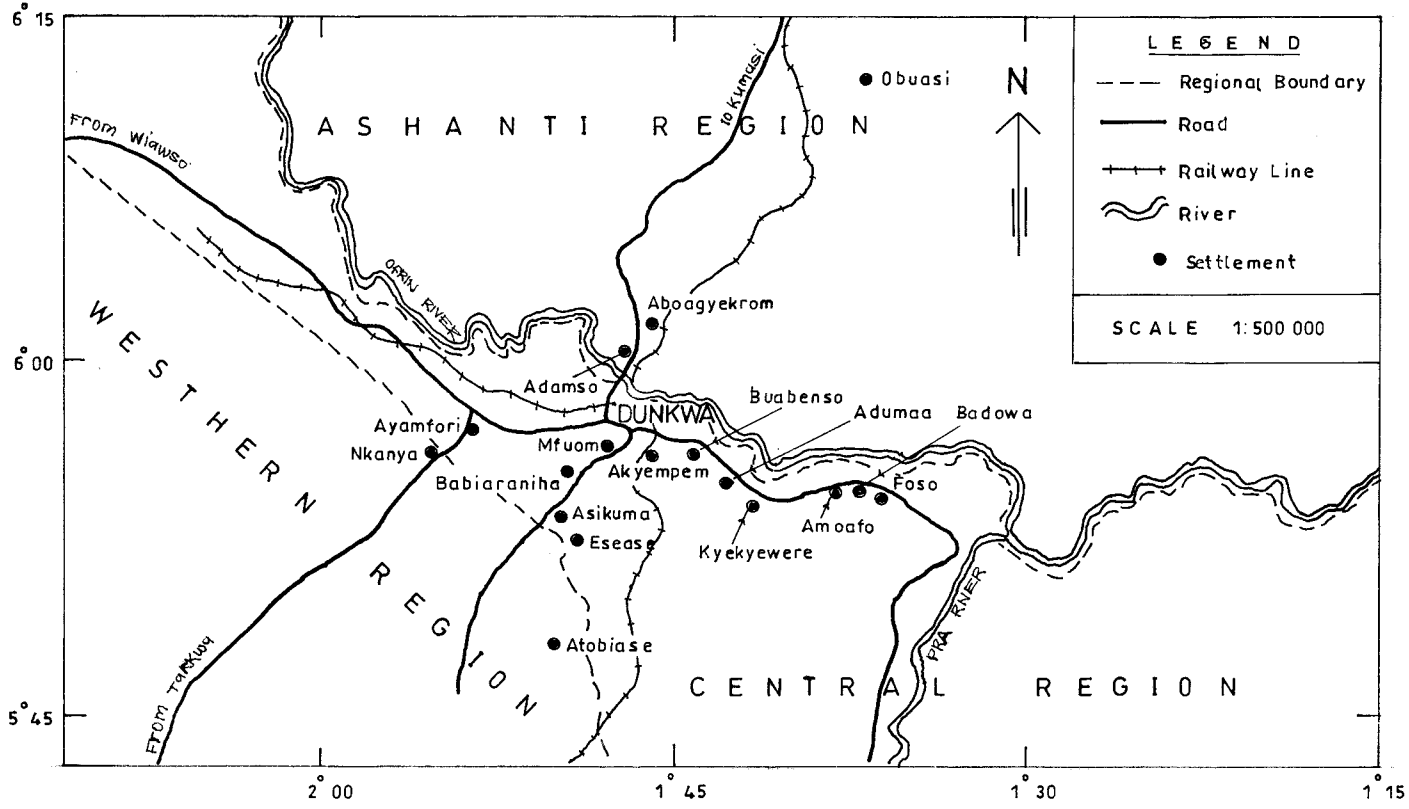

Figure 1. Map showing Dunkwa and some of its surrounding towns

from the plants at about 1m above ground level. These were also put into labelled separate poly ethylene bags, sealed and conveyed to the laboratory.

In the laboratory the soil samples were freed of pieces of roots, leaves, pebbles and other foreign object. They were dried in the oven at 60^{o}C to constant weight. The dried samples were ground and homogenized in a porcelain mortar, sieved with a 200 μm mesh and made into composite samples. They were transferred into plastic containers with lids, labelled and stored at room temperature.

The fresh cassava tubers were each washed gently and rinsed with distilled water and peeled. The fresh peels were removed with a stainless steel knife and separated into the periderm (out skin) and cortex with the fingers in rubber gloves. The flesh and the peels were chopped up into smaller pieces and dried at 60^{o}C to constant weight. These samples were then ground up and homogenized in a porcelain mortar and then sieved with 200 μm mesh, put into plastic containers labelled and stored to await analysis. The periderm, cortex, fleshy core and leaves were separately stored and analysed.

Zinc Content: Ten grams of treated soil sample were weighed into a 100 ml decontaminated beaker, 20 ml of concentrated HNO_3 were added, mixed thoroughly and put on a hot plate in a fume chamber. The mixture was heated for 30 minutes. It was allowed to cool and filtered through pre-washed Whatman No. 1 filter paper and made up to 100 ml mark with double distilled water in a graduated flask. The treated sample were stored in sample bottles and kept at room temperature to await analysis. A blank solution was prepared by diluting 10 ml concentrated HNO_3 in a decontaminated flask to 1 litre.

The reagent blank was first used to zero the AAS/Perkin-Elmer 51000 PV. Air-acetylene flame was used to produce ground state atoms in the flame. With zinc hollow cathode lamp at 2213.9 nm with the lamp at 15 mA.

Accurately weighed 1g of cassava tissue was put in 100 ml decontaminated beaker and 20 ml concentrated HNO_3 added. The sample was thoroughly mixed and heated on a hot plate in a fume chamber. The cassava samples were digested for 20 minutes. The digested samples were filtered through a pre-washed Whatman No. 1 filter paper and made up to 50 ml mark with double distilled water in a graduated flask. The treated samples were stored in sample bottles and analysed in the AAS. Recovery studies by standard addition gave results between 95 to 101% for zinc levels between 0.2 and 1.2 mg/g with standard error of 0.01 and co-efficient of variation of 1.7% for the soil. Recovery studies by spiking the cassava tissues with standard zinc gave similar results.

RESULTS AND DISCUSSION

The amounts of zinc in the surface soil decreased with the depth in

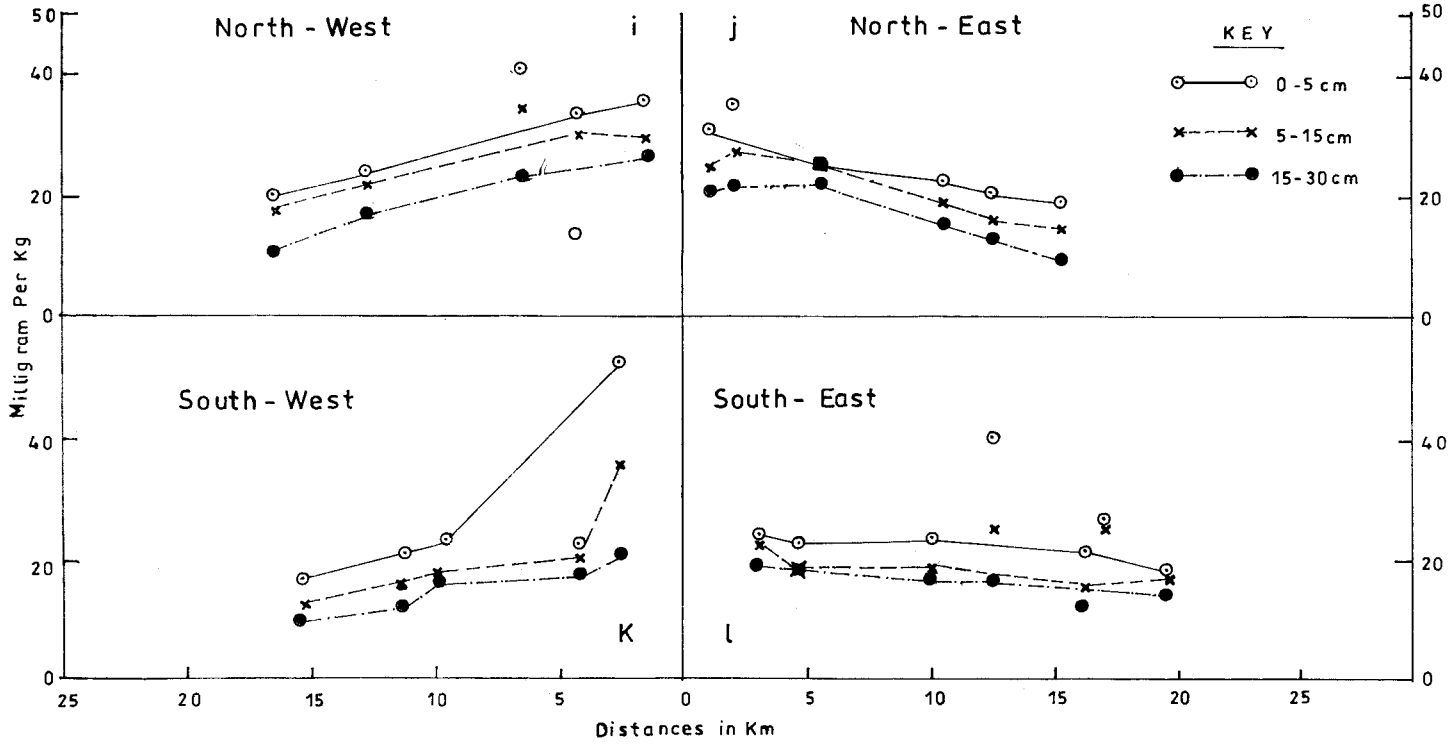

Figure 2. Levels of zinc in various zones of surface soil at various distances from Dunkwa - on - offin

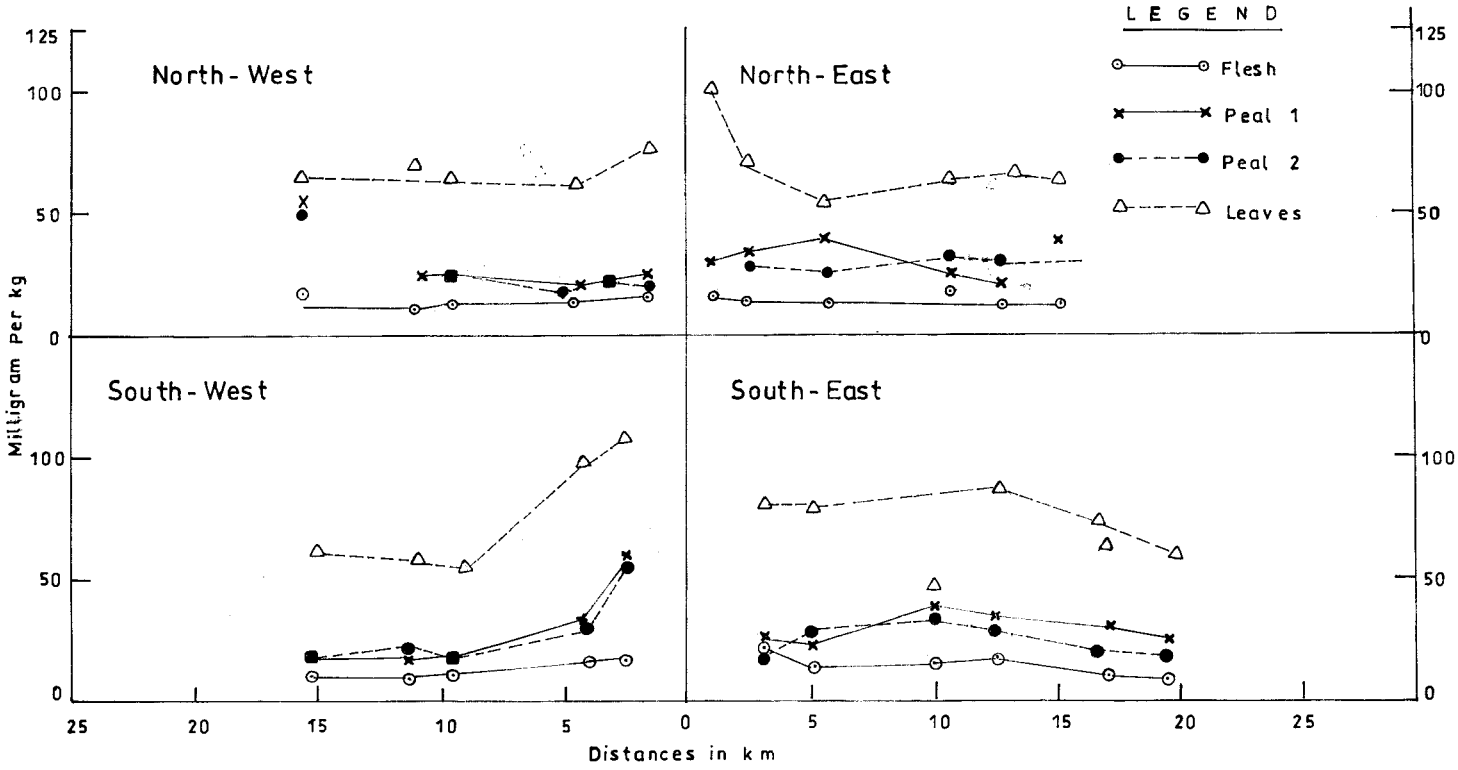

Figure 3. Levels of zinc in cassava leaves, flesh, cortex and periderm at various distances from Dunkwa - on - offin

the three zones, Figure 2. The amounts in the soil decreased with distance from Dunkwa-on-Offin in the three zones. The implication is that the source of zinc was aerial and it came from Dunkwa-on-Offin where it was used for smelting of gold. The zinc which combined with gold vaporized on heating and escaped into the atmosphere where it condensed back to zinc and was blown about by the wind.

In the cassava crop the amount of zinc in the leaves were the highest, Figure 3. The amount in the periderm was higher than those in the cortex and these inturn were higher than those in the flesh, Figure 3. The higher amount of zinc in the periderm might be due to the fact that it was in contact with the soil which contained higher amounts of zinc. The presence of the highest amounts in the leaves with decreasing amounts with distance from Dunkwa-on-Offin is further proof that the source was aerial particulates from town. The presence of the highest amounts in the leaves which in turn is higher than those in the periderm which in turn had higher amount than the cortex and which also in turn contained more zinc than the flesh lends further credence to the fact that the source was aerial. In addition the decrease of the amounts in these tissues with distance in all directions from Dunkwa-on-Offin confirms that it originated from this town where it was used for smelting gold.

Since zinc is not toxic and is required for growth, reproduction and healing of wounds in mammals, the consumption of cassava leaves rich in zinc may be of nutrition advantage. A cassava, tuber improperly peeled may be richer in zinc than the tuber completely divested of the peels as was observed by, Golow 1993. However, zinc usually contains cadmium as an impurity and the toxicity of large amount of zinc is due to cadmium impurities. Cadmium is known to be a metabolic antagonist to zinc and so the levels of cadmium in the soil must be monitored as well, so that the population may be protected against cadmium contamination.

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