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RESEARCH ON THE PHYSICAL PROPERTIES OF WATER

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Abstract:

The water's elemental composition is critical to life. Animals and humans in the food chain rely on water's ability to give them all of the critical nutrients they need. Essential elements such as calcium, magnesium, and potassium can be found in drinking water. Many illnesses can be traced back to a lack of minerals in the environment, leading to deficiency. Nutritional irregularities can take the form of either a deficiency or an overabundance. Many studies have identified a link between water chemistry and cardiovascular deaths[1].

Multi-element water analysis has been performed using the Particle Induced x-ray emission (PIXE) technology. PIXE's great absolute sensitivity allows it to analyze samples of petite sizes[2].

Keywords: composition, Nutritional irregularities etc

TRACE ELEMENT RESEARCH:

Water samples collected from the ash pond at NALCO's captive power plant in Angul were analyzed using PIXE techniques to assess the coal-fired power plant's environmental impact. A wide range of groundwater sources has piqued the curiosity of trace elements. The water samples from two mineral springs in Odisha have also been analyzed. Trace element analysis of water may now be done with shallow detection limits because of the PIXE methodology and preconcentration procedures. Everything from sample preparation through irradiation is described in depth.

(a) **Testing:**

A wide variety of natural aquatic environments can be sampled to get representative water samples. Traces of metals should not enter or leave the container after a sample has been obtained.

Trace elements have found a variety of natural water sources to be interesting. Orissa's two natural hot springs, Atri and Taptapani, are located 40 and 200 kilometres from Bhubaneswar, respectively. The elemental contents of water samples taken from various natural sources were analyzed. Sample preparation for PIXE analysis is complex because of the low metal concentrations in water samples. Mixed precipitation and coprecipitation approaches have been used to obtain the most accurate findings.

In addition, PIXE examined water samples collected on the Institute of Physics (IOP) campus.

Researchers have found trace element analysis to be a valuable tool in assessing water pollution and environmental concerns in various ways. Angul's Captive Power Plant (CPP), NALCO's ash pond, and the ash pond's discharge point have been analyzed to estimate the environmental impact of the coal-fired power plant's operation. NALCO's CPP is located over 200 km from Bhubaneswar. When coal is burned, it produces ash that must be removed from the combustion chamber.

Samples of the water above were stored with 5ml of HC1 per litre in clean plastic bottles. The samples were refrigerated for several hours before being processed. During the two days following the collection of the samples, they were processed.

(b) **PREPARATION OF A SAMPLE:**

If you need information on components with low concentrations (0.1 ppm), you'll need a pre-concentrating procedure. Suppose you want to know the concentration of trace metals in a water sample. In that case, it is usual practice to use a method that comprises a combination of metal chelation, membrane filtration, and analysis of the residue [3].

Precipitation is a simple, fast, and exact sample preparation method for obtaining trace elements from natural water. Due to the low metal content in natural waters, a preconcentration strategy has been used to prepare water samples for coprecipitation of dissolved metals as carbamates. The show relied entirely on borosilicate glass for all of its glasses and apparatus to keep costs low. Hydrochloric and nitric acid solutions were used to clean the equipment, followed by rinsing under 17 MOhm cm 1 resistivity water (Millipore). NaDDTC solution was prepared in a new batch for every experiment to ensure constant concentration. A water sample of 100 ml was used to coprecipitate the metals in the sample. Palladium (Pd) was used as a precipitant and an internal standard in the water. Carbamate elements precipitated in the water sample after ammonia an (iV7i3) and NaDDTC solution was added, bringing the pH to 9. Another intermediate reaction product was palladium diethyldithiocarbamate, which is a water-soluble chemical that can be used as a coprecipitating agent[4, 5]. Nuclepore Polycarbonate Membrane Filter with a pore size of 0.2 pm Diameter was used to filter the sediment. The Nuclepore filter and sample layer on the membrane generated a narrow target. The effectiveness of the filter was tested using a two-stage filtration process. [6] This resulted in a 99.9% efficiency rate for the metal in question. Similarly, SRM 1643, a NIST water standard, was also produced using the same approach.

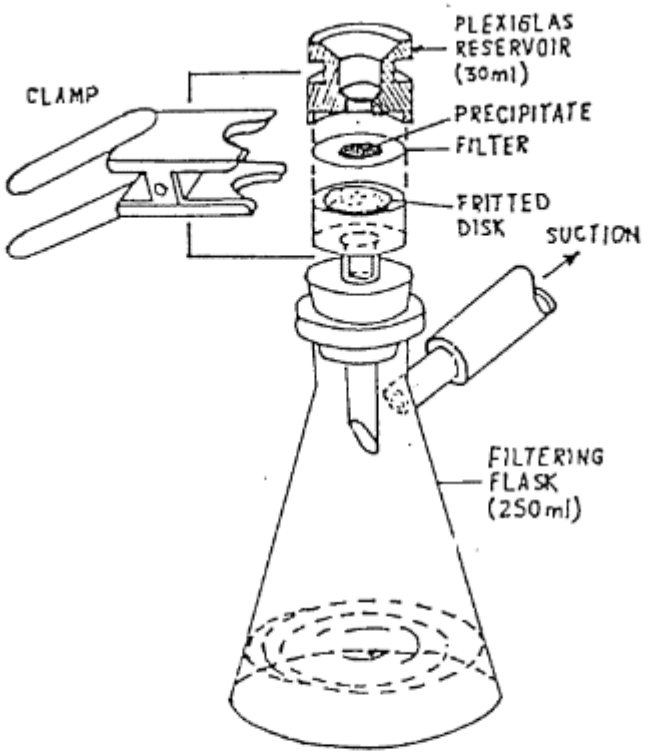

Fig. 5.1 A vacuum filtration unit used for preparation of thin target of water

(c) Irradiation of a specific area of interest:

Customized target holders were used for radiation treatment on thin targets. A 3 MeV proton beam and a beam current in the range of 2-8 nA were used to irradiate targets at 45° to the beam in a vacuum of I0-6 Torr. The beam current was kept as low as feasible to avoid target degradation. X-rays from the sample were analyzed using a Si(Li) detector. The spectrum was captured with a Canberra series 88 multiparameter analyzer. The NIST water standard's PIXE spectrum is shown in Figure 5.2. The PIXE spectra of Atri and Taptapani hot spring water samples are shown in Figures 5.3 and 5.4, respectively.

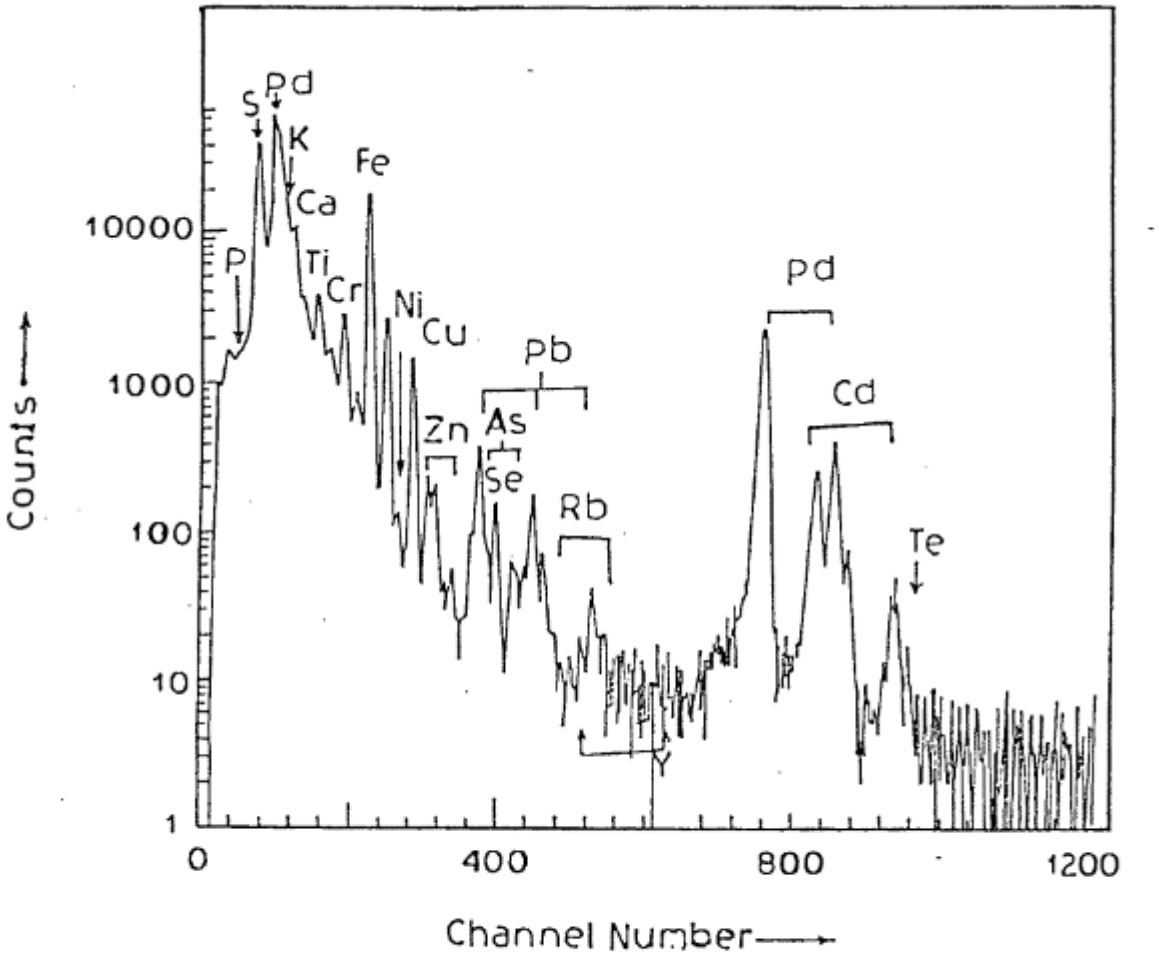

Fig. 5.2 X-ray spectrum from 3 MeV proton bombardment of NIST water standard(SRM 1643)

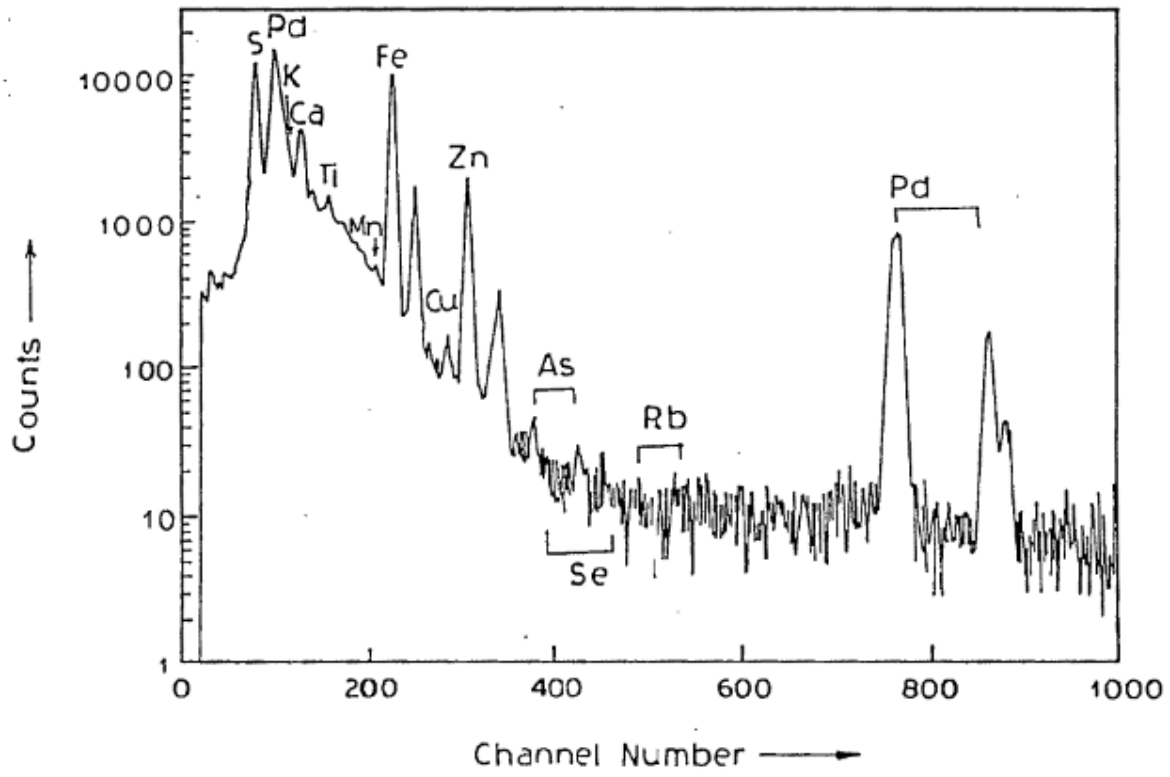

Fig. **5.3** PIXE spectrum of water from hot spring at Atri

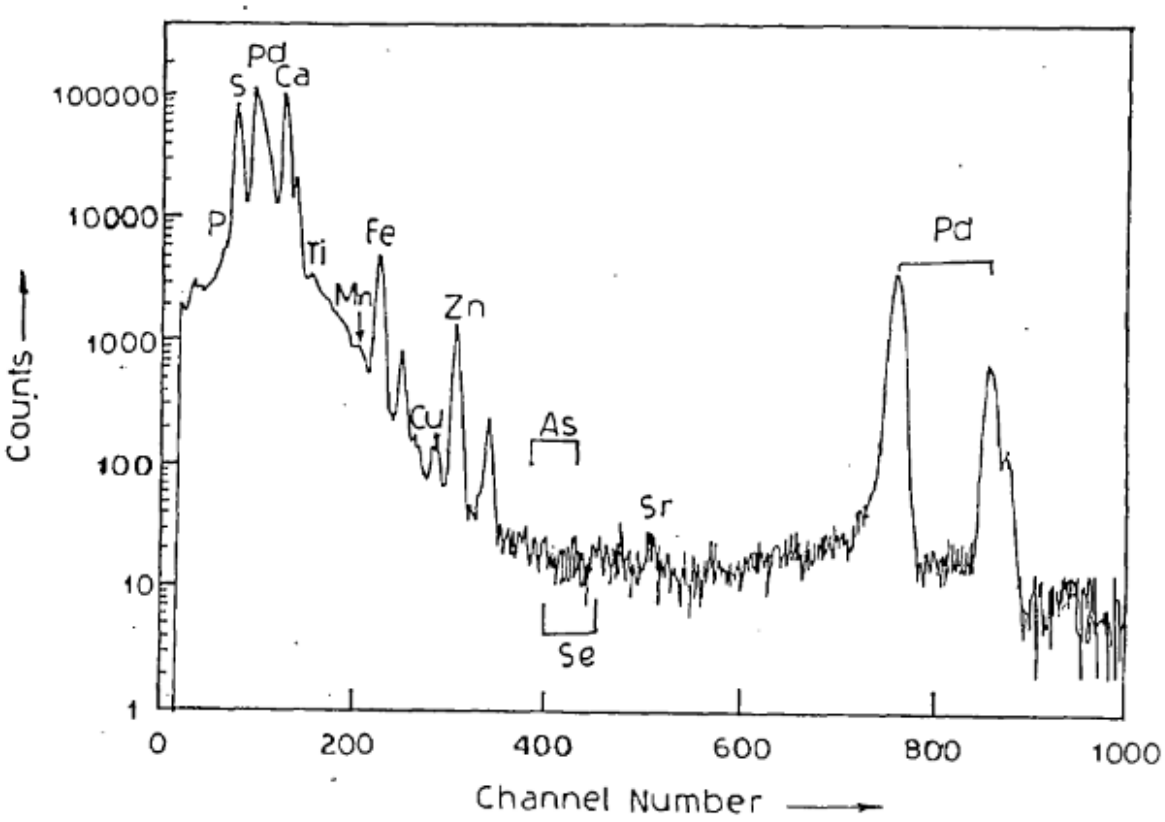

Fig. 5.4 PIXE spectrum of Taptapani water

(d) Analysis of the frequency spectrum:

As described in Chapter 2, the GUPIX software was used to analyze each thin target's PIXE spectrum. For standardization, standard foils were analyzed using micrometre thin foils. The PIXE measurements of water samples were also tested against the NIST water standard (SRM 1643)

(e) Discussion of the findings:

As part of the precipitation technique, it was necessary to use a blank target to look for chemical reagent-related contamination in water sample analysis. A small quantity of contamination was observed in the reagents.[5] With this approach of target preparation, homogenous dispersion of materials can be achieved while handling is minimized and contamination is avoided. We employed NIST water standards to ensure that our PIXE results were accurate (SRM 1643). We obtained accurate results by comparing our findings to certified data (table 5.1). Table 5.2 displays water samples collected from the hot springs of Atri and Taptapani. It was discovered that the quantities of calcium and iron in Atri water samples were higher than those found in Taptapani water samples. Cr, Ni, and Cu concentrations were incredibly low in both cases. [7] For Atri and Taptapani natural hot spring water samples tested using the PIXE method, the World Health Organization (WHO) has determined a maximum amount of metals found in the water that can be consumed. It is shown in Table 5.3 that IOP campus water samples were analyzed.

Table **5.1** : Results of analysis of NIST water standard(SRM 1643) (concentrations in $\mu g\ l^{-1}$)

Element	NIST Certified	Measured
K	(2300)	2186.8 ± 325.9
Ca	36800 ± 1400	31401.7 ± 1551.3
Ti	—	8.6 ± 0.4
V	31.4 ± 2.8	31.3 ± 5.6
Cr	19.0 ± 0.6	17.8 ± 1.2
Mn	35.1 ± 2.2	30.1 ± 4.3
Fe	106.9 ± 3.0	110.8 ± 5.1
Ni	60.6 ± 7.3	49.4 ± 9.5
Cu	22.3 ± 2.8	20.2 ± 1.2
Zn	73.9 ± 0.9	67.2 ± 4.8
As	82.1 ± 1.2	77.5 ± 5.9
Se	12.7 ± 0.7	11.2 ± 0.8
Rb	11.4 ± 0.2	10.1 ± 1.3
Ag	2.2 ± 0.3	2.4 ± 0.3
Bi	(12)	13.8 ± 1.9
Cd	12.2 ± 1.0	14.0 ± 1.1
Pb	35.3 ± 0.9	36.3 ± 2.9

Table **5.2** : Elemental concentrations($\mu g\ l^{-1}$) in water samples from Atri and Taptapani hot springs and WHO drinking water standards

Element	Atri	Taptapani	WHO standards	
			Permissive	Excessive
K	1.0×10^3	2.3×10^3	10×10^3	12×10^3
Ca	47.6×10^3	16.6×10^3	75×10^3	200×10^3
Cr	2.1	1.6	50	—
Mn	10.4	44.7	50	500
Fe	185.2	127.6	300	1000
Ni	20.2	14.9	—	—
Co	9.4	—	—	—
Cu	89.1	25.0	1000	1500
Zn	75.5	62.7	5000	15×10^3
As	4.4	6.1	50	—
Pb	1.4	3.1	50	—

Table **5.3** : Elemental distribution of water from Institute of Physics(IOP) campus (concentration in $\mu g\ l^{-1}$)

Element	Mean concentration
K	1300.2 ± 55.9
Ca	114700.5 ± 5920.3
Cr	1.6 ± 0.3
Mn	32.0 ± 2.9
Fe	203.3 ± 11.6
Co	22.6 ± 3.4
Ni	21.8 ± 1.7
Cu	65.2 ± 5.5
Zn	100.1 ± 6.4
As	6.1 ± 1.0
Pb	1.9 ± 0.3

NALCO ash pond water samples are listed in Table 5.4 with their elemental concentrations. The most significant amounts of K and Ca were identified, whereas the lowest concentrations of Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se and Mo were discovered. According to the WHO, the maximum permissible concentration of Fe in drinking water is 300 /ig 1 1. (WHO).

Table **5.4** : Average elemental distribution (in $\mu g\ l^{-1}$) of water from differer locations of CPP of NALCO at Angul

Element	Concentration	
	Ash pond	Discharge point of ash pond
K	1400 ± 53.3	1200 ± 48.2
Ca	195600 ± 7824.2	49300 ± 2218.5
Ti	119.0 ± 12.1	73.3 ± 6.9
Cr	4.5 ± 0.8	3.2 ± 0.7
Mn	129.8 ± 15.0	89.4 ± 10.4
Fe	423.7 ± 25.7	339.2 ± 21.8
Co	15.4 ± 2.7	11.1 ± 1.9
Ni	133.0 ± 7.5	61.2 ± 4.4
Cu	44.7 ± 3.2	31.5 ± 2.7
Zn	89.1± 5.6	81.1 ± 5.2
As	3.0 ± 0.4	2.3 ± 0.3
Se	9.5 ± 1.1	8.6 ± 1.2

The PIXE method can identify metals at low concentrations in natural and industrial water sources. The PIXE equipment at the Institute of Physics is a potential analytical tool that will be useful in the future for analyzing a variety of water samples.

Studies on radioactivity:

(a) Introduction:

40K is the primary cause for the lower natural radionuclide concentrations in water than in rocks and soils. These two radioactive elements are significantly concentrated in the sediments at the bottom of the ocean, although they are more often found in the water. In drinking water, radionuclide concentrations, for example, can vary greatly depending on the type of rock or soil and the type of geochemistry present[8].

If radionuclides discharged into the environment are dissolved or suspended in a liquid effluent, humans may be exposed to radiation directly and indirectly. Dose rates are calculated using radiation measurements or estimates based on the radioactive concentration in water. In light of how much water we consume[9], water's role in delivering radionuclides to humans may be considered essential. Consequently, water samples must be analyzed for radioactive contents.

(b) Sampling and subsequent data analysis:

It has been used to analyze water samples from Orissa's Atri and Taptapani hot spring natural hot springs for radioactive content.

Identifying radionuclides in water at low concentrations necessitates the use of large samples. To improve the sensitivity or accuracy of the measurements, it may be necessary to increase the specific activity of the radionuclides first.

At a temperature of 200 degrees Celsius, a water sample that had been 5 1 ml was reduced to 200 ml. The sample was stored in airtight cylindrical plastic containers (6.50 cm dia. x 7.5 cm ht) for around four weeks to guarantee that 226Ra and 232Th reached radioactive equilibrium with their respective daughters.

(c) **Counting the number of samples:**

Radiation levels can be measured using the gamma-ray spectrometer, explained more fully in Chapter 2. Shielding and direct contact with the detector were used for counting purposes on the page. The samples' gamma radiation was detected by the HPGe detector and recorded using PC-based MCA software in about 60000s. The GANAAS tool was used to analyze the gamma-ray spectra.

(d) **Discussion of the findings:**

Data from Azul and Taptapani hot springs are shown in Table 5.5. These samples included 0.5 and 0.7 Bq l-1 of 226Ra. The 232Th content was less than 0.5 Bq l-1, which is the detection limit. These results were comparable to those found in natural waters [10]. The gamma-ray emitting naturally occurring radioactive components in the water of these Orissan hot springs are being studied to acquire baseline data.

Table **5.5** : Radioactivity levels of natural radionuclides in water from Atri and Taptapani hot springs (in Bq l^{-1})

Radionuclide	Atri	Taptapani	Literature values for natural waters
^{226}Ra	0.5 ± 0.1	0.7 ± 0.2	0- 1.1
^{232}Th	< 0.5	< 0.5	0- 0.8
^{40}K	4.7 ± 0.4	4.5 ± 0.4	0-12

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