Chapter 1

Introduction

Heavy metals emissions into the biosphere as the result of industrial activities are increasing. Some of these heavy metals are hazardous to human health. Therefore, the method used to trace them must be precise and accurate. Many systems have been developed and are available now for tracing these elements in a sample form. However, the choice of analytical method depends on the exact nature of the problem to be addressed and also the budget. Some criteria used in the selection of an appropriate trace analytical technique are sensitivity, accuracy and precision.

Two methods have been used in this study, namely X-ray Fluorescence (XRF) and Inductively Coupled Plasma—Atomic Emission Spectrometry (ICP-AES).

X-ray fluorescence is the method, which can identify the heavy metal elements instantly. For example, XRF has been developed to employ γ-rays from ^{109}Cd to excite lead K x-rays (Chettle et al, 1991; Jones et al, 1987; Hu et al, 1991; Green et al, 1992). The 122 keV γ-rays from ^{57}Co are also used to excite the K x-rays (Nilsson et al, 1991; Craswell et al, 1986) and the L x-rays are measured in a system which uses an X-ray tube with a silver target, whose output is partly plane polarized (Wielopolski et al, 1989). Thus, from these success in fluorescence analysis and emission microanalysis, X-rays techniques can also be applied with ease in *invivo* study of particular tissues in which the counts per unit dose require a high degree of measurement sensitivity (M.J.Farquharson and D.A. Bradley, 1999). The first in vivo measurement used 122 keV γ-rays from a ^{57}Co source to excite lead K-lines from finger bones (L. Ahlgren and S. Mattsson, 1979). This technique has been further developed to apply on population studies by others (Price J et al, 1984). However, the extent of application of *in vivo* evaluation of concentrations of toxicological metals will depend upon the fluorescence radiation which is attenuated in those parts of the body in which the metal accumulates (D.A.Bradley and M.J.Farquharson, 1999).

The Inductively Coupled Plasma—Atomic Emission Spectrometer is a well-known tool for the spectrochemical analysis of solvents. It is based upon the emission of light from elemental species aspirated into high temperature argon plasma, which is used for excitation of contained elements.

Since its development in the early sixties, many researchers have contributed to the ICP development, in which some of them studied the characteristics of ICP for exploring the fundamental considerations of the ICP discharge and also the optimization for plasma operation. For example, Mermet and Trassy (1981) was focusing on the spectral interferences with an ICP in atomic emission spectroscopy, while G.R.Kornblum (1981) and L.Ebdon (1981) studied the principle and optimization of plasma operation.

The precise and accurate performance of ICP is the reason for its wide application in the various analytical fields. For example, the use of ICP-AES in analysis of the concentration of heavy metals in plants (Vojka Kos et al, 1996), the analysis of the human blood serum (J.M. Mermet, and C. Trassy, 1981), the determination of the elements of lead and cadmium in zinc salts used as food additives (Suddendorf, R.F. et al, 1981) and elemental analysis in agriculture (Hern, J.L., 1979). Besides, ICP-AES has also very high detection sensitivity, which is able to detect the concentration of up to sub parts per billion (A.J.Mitteldorf, 1965).

Therefore, the objectives of this project are:

1. To trace the heavy metal elements (Pb, Cd, Zn, Cu, Ca and Mg) in the human teeth; in the samples collected from Klang Valley and Malacca by the method of ICP-AES.
2. To study the concentrations of these heavy metal elements present in each tooth and further investigate the relationship between them if there is any. Also this study will observe the effects of the working environment upon the concentration of the various elements. Correlation coefficient between the concentrations of these heavy elements with the donors' age will also be the main focus. The concentration of each element between the samples from Klang Valley and Malacca will also be compared.
3. To set-up an alternative method to detect the concentration of Pb in human teeth by XRF method. Tc-99m has been used in this system which is coupled with the X-ray and γ-ray XR-100T-CZT detector. Theoretical calculation is performed to cross check the XRF experimental results.
4. Finally, to make comparison between the result of Pb concentrations in the teeth samples obtained using the ICP-AES method and XRF technique.

This thesis contains 7 chapters with the starting chapter being an introduction of the work done by other researchers. Chapter 2 focuses on a brief discussion of the effects of elements (Pb, Cd, Zn, Cu, Ca and Mg) to human health, while chapter 3 delves into the foundations and theories of XRF and ICP-AES.

Chapter 4 concentrates on the experimental methods of XRF and ICP in detail. Chapter 5 and 6 presents the results and discussions on XRF and ICP methods respectively.

Chapter 7 is the conclusion of the whole work and some suggestions for future works.

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