This chapter primarily deals with methodological steps taken up for the present investigation. This chapter was divided into three subsections. The Section –I describes the collection of health data of study subjects (teachers) through questionnaire. Section-II multi-elemental characterization of chalk & chalk dust collected from schools using both analytical and nuclear techniques. Section-III is a case study to sensitize and few protective measures as a trial basis in selected study subjects (teachers) to implement against occupational health hazards of teachers.

3.1. SECTION-I

3.1.1. SETTING OF THE STUDY

The study was carried out in and around Visakhapatnam, Andhra Pradesh, India(Fig.2). To conduct this study permission from District Educational Officer (D.E.O) was obtained. According to the list provided by District Educational Office, there are about 444 registered government schools in Visakhapatnam city. Out of which 256 schools are high schools and 188 schools are primary schools. Among the 444 schools, 342 schools are responded positively (144 primary schools and 198 secondary school). No single private school responded positively for this study.
Fig. 2. Study area and selected schools

Sources: www.google.maps.in
3.1.2. STUDY SUBJECTS

The study subjects constitute both primary and secondary government school teachers.

3.1.3. SUBJECT SELECTION CRITERIA

The study subjects (teachers) those responded positively were chosen for this study. Those responded negatively, Study subjects (teachers) having minimum experience of one month and female pregnant teachers are not considered for this study.

3.1.4. VARIABLES UNDER STUDY

The variables selected for the this study were adopted from the study carried out by Manjula (2012). Occupational health hazards, personnel characteristics like age, gender, food habits and academic characteristics like mode of teaching and hours of teaching were considered as variable for this study.

3.1.5. LEVEL OF STUDY SUBJECTS (TEACHERS)

Sample of the study comprises of 342 government schools, out of which 144 primary schools and 198 secondary schools. The study subjects (teachers) percentage was also varied from area to area and school to school. The number of study subjects (teachers) as 3 to 7 and 5 to 12 for primary and secondary school teachers respectively.

A total of 1962 (576 primary school and 1386 secondary school) study subjects (teachers) were requested to participate in this study. Out of 1962 study subjects (teachers) 1752 (432 study subjects (teachers) from primary school 1320 study subjects (teachers) from secondary school)
were responded positively, 90 study subjects (teachers) did not give their consent to participate in study, 70 study subjects (teachers) did not return the questionnaire and 50 study subjects (teachers) returned the incomplete questionnaires.

3.1.6. TOOLS/INSTRUMENT USED FOR THE STUDY

In the present study, both questionnaire and personnel interviews were used as a tool to collect the data. Questionnaire is used to gather the information about the occupational health hazards of teachers. The interviews are conducted to know the perceptions of teachers towards occupational health hazards.

3.1.7. QUESTIONNAIRE PREPARATION

The primary method of health data collection was done through questionnaire. Questionnaire was prepared based on the reference studies and group discussion conducted between the teachers.

The questionnaire consists of three sections, namely school particulars, socio demographic characteristics and occupational health hazards (Annexure-I).

3.1.8. DATA COLLECTION

The schools were approached personally with the order letter of District Educational Officer (Annexure-II). After obtaining the permission from the respective school headmasters/principals, the questionnaires were distributed to the study subjects (teachers). The research objectives were clearly explained to participants and then clarified all their queries related to the study and questionnaire (Plate-I). One week time was given to fill the questionnaires and information was
updated through telephonic conversations. They were also made to understand that the response given by them was kept strictly confidential.

3.1.9. STATISTICAL ANALYSIS

Data was analyzed by using statistical package for social sciences (SPSS) 20.0.

3.2. SECTION-II

This section depicts about the multi elemental characterization of chalk and chalk dust using both analytical and nuclear techniques.

1. Trace element characterization of five selective locally available brands of chalk was carried out using Energy Dispersive X-rayfluorescence (ED-XRF)(Sudharshan et al 2011) & also chalk dust(settled and suspended) collected from classrooms was analyzed using Inductive Coupled Mass Spectroscopy (ICPMS)(Chudzinska et al 2012).

2. Particle size of locally available brands of chalk was performed (Deepanjan Majumdar & Willaim 2009).

3. Image studies of collected chalk dust were also performed using Scanning Electron Microscopy (SEM) (Deepanjan Majumdar & Willaim 2009& Manish Thakker et al 2015).

3.2.1. ENERGY DISPERSIVE X-RAY FLUORESCENCE (ED-XRF) METHOD

3.2.1.1. SAMPLE COLLECTION
The frequently used five different brands of both dusted & dustless chalk sticks are purchased from local markets. Each brand was provided with different codes. The chalk samples were grinded and homogenized using mortar and pestle followed by digestion process (Majumdar et al 2009 & Joseph 2016).

### 3.2.1.2. SAMPLE PREPARATION

Each sample was pressed with a tabletop pelletizer by applying a pressure of 100kg/cm² for 5min resulting pellets have a diameter of 1mm thick and uniform mass of 150mg (Plate-2). All the samples were prepared in triplets. Further analysis of elemental characterization of elements like Calcium, Aluminium, Iron, Silicon, Nickel and Chromium in each chalk sample was done by using ED-XRF (Majumdar et al 2009). This test was conducted at Trace element research laboratory, UGC- DAE Consortium centre for scientific research, in Kolkata centre. The samples were given with the following codes.

Table-1: Codes used for the samples

<table>
<thead>
<tr>
<th>Sample no</th>
<th>Codes given for Dustless chalk</th>
<th>Codes given for dusted chalk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D.S-1</td>
<td>D.D-1</td>
</tr>
<tr>
<td>2</td>
<td>D.S-2</td>
<td>D.D-2</td>
</tr>
<tr>
<td>3</td>
<td>D.S-3</td>
<td>D.D-3</td>
</tr>
<tr>
<td>4</td>
<td>D.S-4</td>
<td>D.D-4</td>
</tr>
<tr>
<td>5</td>
<td>D.S-5</td>
<td>D.D-5</td>
</tr>
</tbody>
</table>
3.2.1.3. EXPERIMENTAL SET UP

The set-up consists of a Xenemetrix (Previously Jordan Valley) Ex-3600 EDXRF spectrometer (Plate-3). This consists of an X-ray tube with a Rh anode as the source of X-rays with a 50V, 1mA power supply, Si (Li) detector with a resolution of 143 eV at 5.9keV. X-ray and 10-sample turret enables mounting and analyzing 10 samples at a time. The quantitative analysis is carried out by the in-built software nEXt.

3.2.1.4. ED-XRF MEASUREMENT

The measurements were carried out in a vacuum using different filters (between the source and sample) for optimum detection of elements (Sudharshan et al 2011). For example for the detection of elements Aluminium, Silicon, Potassium, Calcium, Titanium, no filter were used, and a voltage of 7 kV and current of 75μA were used (Sudharshan et al 2011). For this study all the chalk samples were analyzed for the elements like Aluminium, Silicon and Calcium, measurements were carried out for 200-S. and for the elements like Iron, Chromium and Nickel measurements were carried out in 400-S. (Plate-3)

3.2.2. INDUCTIVE COUPLED MASS SPECTROSCOPY (ICP-MS) METHOD

3.2.2.1. SAMPLE COLLECTION & PREPARATION

Suspended chalk dust was collected from selected classrooms by using fine dust sampler (Envirotech make, Model no APM550). The sampler was run for 8 hours (from morning to evening) during working days. The sampler was kept near to the board at a height of 1-2metres in the classroom at which the pupils would normally inhale (Plate-4) (Fromme et al 2007).

The settled chalk dust samples were collected from the selected classrooms during teaching hours by placing petriplate near to the black board to a distance of 3metres for 30minutes (Plate-
Samples were collected in triplicate. Based on the standard method and owing to the fact that settlement is more between 0-3 metres distance from the board.

3.2.2.2. DIGESTION PROCEDURE ADOPTED

3.2.2.2.1. SUSPENDED CHALK DUST

Based on the reference studies microwave digestion process was followed (Sharma et al 2005). Filter papers were digested using Hydrochloric and Nitric acid mixture (3:1) by microwave digestive system (CEM) for 23 minutes at about 180°C. The digested samples were filtered and stored in volumetric flasks.

3.2.2.2.2. SETTLED CHALK DUST

The known concentration of settled chalk dust sample were taken and digested by adopting standard digestion process with Nitric-perchloric acid and then the digested samples were analyzed further for trace elements characterization (Hseu 2004).

3.2.2.3. EXPERIMENTAL SET UP

The Agilent 7700s inductively coupled plasma mass-spectroscopy (ICP-MS) system (Agilent Technologies, Tokyo, Japan) was engaged to assess the ion profile. Platinum sample cone and skimmer cone were utilized with an orifice diameter of 1.0 to 0.4 mm, respectively. Sample
introduction was performed with a micro mist nebulizer combined with scott-type double pass spray chamber (Agilent technologies).

The instrument was tuned to optical conditions in terms of sensitivity (Li, Y, Co and Ti) and CeO/Ce and Ce$^{2+}$/Ce by using a tuning solution (Agilent technologies) containing 1mg/L of Li, Y, Ti, Ce and Co in 2% HNO$_3$ (W/V). The instrument was operated in full quantitative mode, and typical operating conditions used in this study are summarized in the table-2.

### 3.2.2.4. VALIDATION OF ICP-MS (Inductive Coupled Mass Spectroscopy)

To validate the method, three randomly selected chalk samples mixed together spiked with known concentrations. From the results percentage recoveries were calculated based on the following equation (Chudzinska et al 2012).

\[
\text{Percentage recovery} = \frac{\text{CE}}{\text{CM}} \times 100
\]

Where CE is the experimental concentration determined from the calibration curve and CM is the spiked concentration.

### 3.2.3. PARTICLE SIZE ANALYSIS

The different brands of chalk samples were sent to the Hyderabad (Nishka laboratories) (Deepanjan Majumdar & William 2009).

### 3.2.4. SCANNING ELECTRON MICROSCOPY

For sample preparation the chalk dust particles and the filter papers were coated with ultra thin film of gold by an ion sputter JFC-1100. Immediately after coating image studies (Plate 6-9& 10-
were performed using the electron microscope (JEOL, JXA-8100)(Majumdar & William 2009 & Manish Takker et al 2015)

3.3. SECTION-III

This section aims to propose protective measures for improvement of study subjects(teacher) health through a case study. The case study includes the following steps:

Step1: The preliminary Spirometric analysis was conducted to the participants to assess pulmonary function of teachers prior to implementation of suggested protective measures.

Step2: Protective measures were proposed and suggested to follow for six months

Step3: The post Spirometric analysis was conducted

Total 134 government schools were agreed to carry out the proposed study. After taking the consent of study subjects (teachers), then all the study guidelines were explained to the teachers. Preliminary Spirometric analysis was taken and safety measures were suggested and advised them to follow those for six months. Throughout the study period, study subjects (teachers) were in touch and after six months post spirometric analyses were conducted.

3.3.1. SAMPLE SIZE

A total of 250 study subjects(teachers) were approached for this study. Among 250 study subjects (teachers) only 186 study subjects(teachers) were responded positively. Among the 186 study subjects(teachers), 15 were on long leave, 36 study subjects(teachers) were transferred to different places 84 study subjects(teachers) failed to follow the suggested safety measures till the end. Finally 51 study subjects(teachers) (17 primary school and 34 secondary school) were actively participated in this study.
3.3.2. SAFETY MEASURES SUGGESTED TO TEACHERS

Study subjects (teachers) are provided with the dustless chaliks, chalk holders. A chalk piece rolled in butter paper and tied with rubber band (Plate-14) was suggested to avoid contact with chalk pieces instead or during the unavailability of chalk holders and dustless chaliks. Deepanjan Majumdar et al (2009) stated that “When teacher is speaking continuous inhalation of air would be more due to frequent opening and deep breathing leads to more inhalation of chalk dust”, so fresh air breaks for 5-10 minutes after every lecture was suggested. Majumdar et al (2009) also stated that “Use of ceiling and pedestal fans can cause drifting of settling chalk dust into the classrooms” so teachers were suggested to turn off their pedestal fans during their teaching session if not; at least during erasing the board. The teachers are also suggested to demand the management to maintain clean board.

3.3.3. SPIROMETRIC ANALYSIS

Spirometric measurements were carried out according to the American thoracic society guidelines (Vilke et al 2000). The analysis was carried out using the instrument Helios 704 (make RMS)(Plate-15). The study subjects (teachers) were asked to stand and inspire and expire as rapidly as possible (Plate-16). The test was performed three times and best of three reading was obtained and saved. This spirometric analysis was carried out to measure pulmonary function tests in study subjects (teachers) before as well as post implementation of suggested protective measures.