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DISTRIBUTION OF SOME ELEMENTS IN THE CUTTLE FISH *SEPIA OFFICINALIS* SHELLS AS INDICATORS FOR MONITORING HEAVY METAL WATER POLLUTION

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ABSTRACT

The chemical composition, minor and major elements concentration and microstructure of juvenile and adult shells of *Sepia officinalis* were investigated by using electron X-rays and scanning electron microscope. The results generally showed significantly higher metal concentration in the juvenile shell than in the adult one, except calcium and aluminum. However, the highest accumulation was for copper, lead, and cadmium. The relationships between metal concentration and shell length, weight, and position were determined.

However, no relationships between heavy metals pollution and microstructure of the shells of the investigated cephalopod were observed.

INTRODUCTION

It is a known fact that the marine invertebrates accumulate metals in their tissues and due to this ability, they are currently used as indicators of metal pollution (Rainbow, 1993). Mollusks also contain relatively high concentration of certain trace elements, focusing mainly transition metals in their soft tissues (Vinogradov, 1953; Bowen, 1966; Pentreath, 1973 and Valiela *et al.*, 1974; Forester, 1981; Salanki *et al*; 1982 and Hemelraad *et al.*, 1988). In Egypt, Abdel Moati and Farag (1991) studied the rate of bioaccumlation of some heavy metals in the freshwater snail *Lanistes bolteni* at Lake Edku and El Fayomy (1994) found that the marine clam *Cardium edula* in Lake Manzala accumulated more heavy metals than examined fishes. More recently, Ibrahim *et al.*, (1997) studied the effect of certain water pollutants on the clam *Caelatura.*

The molluscan shell has been a subject of intensive research in ecology and paleoecology for many years. However, it was centered around the examination of macroscopic growth features on the surface of the shells and utilization of these growth bands in the investigation of environmental and paleoenvironmental conditions in marine ecosystems. Most of that research was carried out on analysis of bivalve shells, but very little is known about cephalopod shells.

In the present study an explanation of the effect of environmental pollutants on the shell microstructure and chemical composition of the cuttle fish *Sepia officinalis* has been attempted. In addition, special concern has been paid to declare the correlation between shell age and percentage of accumulating metals in an attempt to use shell as an indicator for metal pollution.

MATERIAL AND METHODS

Adult and juvenile specimens of *Sepia officinalis* were caught from the same localities in Abo-Qir, Alexandria waters. They were immediately dissected and their shells were removed for further investigation.

Scanning electron microscopy (SEM):

The shells were washed and immersed in sodium hypochlorite for one hour to remove adhering organic matter. Then, they were washed with distilled water, dehydrated in ethanol, and they were dried in air. Small pieces of shells from three different regions were cut and attached to aluminum stubs with duco-cement and sputter coating with goldpalladium then they were examined by J.S.M5300 Jeol SEM.

Instrumentation:

X-ray electron analysis was used for determination of the concentration of major and minor elements.

RESULTS AND DISCUSSION

Shell microstructure:

The shells of juvenile and adult specimens of *Sepia officinlis* share many similarities in their microstructure. The shells have calcified phragmocone which extends forward to form a preostracum spine and guard which are surrounded by two wings and consist of non calcified fibrous-like material (Figs.1, 2 and 4). The phragmocone consists of many chambers separated from each other by calcified septa (Fig. 5). Each one has central pore surrounded by septa necks and form siphuncle (cord) in the frontal region (Figs. 2, 3). The Shells consist of three layers: outer calcified periostracum (Figs. 6,7and 8), middle prismatic (Figs. 6, 9, 10 and 11), and the last Lamellar (Figs. 6 and 12).

Analyses of the shells:

The analysis was carried out on the outer and inner parts of both types of shells. Considerable variations in their composition were observed. The total concentration of the major elements indicated a high concentration of sodium, potassium and chlorine, and there is less calcium content in the juvenile shell (Table 1 and Figs.13, 14, 15 and 16). These results agree with those of Vinogradoy, (1953) and Rosenberg (1972, 1973). Although, a great concentration of aluminum was found in the external parts of the adult shell, calcium concentration continues to increase with age.

The concentration of trace elements also showed considerable variation from the juvenile to the adult shell and from one surface to another (Table, 1 and Figs. 13,14,15 and 16). The juvenile shell contains unusually high concentration of copper, lead and cadmium (Table, 1 and Figs, 13 and 14). This result agrees with Pip, (1990) who reported that copper and lead concentrations per unit body weight of *Anodonta grandis* mussels decreased as size of the individual increased. Similary, Foster and Bater (1978) found that copper concentration in *Quadrula quadrula* was inversely related to body weight. Hinch and Stephenson (1987) showed that smaller individuals of *Elliptio complanate* contained higher levels of copper in the gills than did larger one.

The present study on *Sepia officinalis* shells indicated that metal concentrations tended to decrease with increased size and body weight. So, younger animals may accumulate metal to higher concentrations in many organs than do older individuals, and therefore may be at greater risk in polluted environments .It should be noted that size and weight were only broad indicator of relative age. In the present study, copper and lead were correlated with each other in the greatest number of shells. However, the greatest concentration of copper and cadmium were found in the inner parts of juvenile shell (Fig. 14). This fact shows that the effect of copper is dependent not only upon concentration and duration of exposure but also on the age or size of the animals .In addition copper interferes with growth and development.

However, higher concentration of cadmium was found in the external parts of juvenile shells. This may be due to adherence of extraneous material. The amounts of cobalt and nickel were similar in external and internal parts of both shell (Table 1)

The present results supporte the findings of Hinch and Stephenson (1987) and Green *et al.* (1989) that concentration of trace metals in mollusks depend on the metal, tissue type, size and age. Many other variables may also potentially influence metal accumulation, for example growth rate, reproductive activity and presence of other metals and pollutants.

ACKNOWLEDGMENTS

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Table 1. Elemental composition of the shells of the juvenile and adult of *Sepia officinalis*

Elemental composition	Juvenile		Adult	
	Ex 2	In 2	Ex 1	In 1
Sodium	16.84	0.45	6.62	4.07
Aluminum	7.34	3.86	11.28	0.28
Chlorine	19.84	1.37	6.49	1.59
Potassium	0.85	0.74	- 0.17	0.92
Calcium	48.56	85.52	73.87	96.84
Nickel	0.63	- 0.52	0.99	- 2.23
Cobalt	0.73	- 0.60	1.04	- 2.40
Copper	4.19	8.35	2.32	0.52
Cadmium	1.75	0.23	- 1.40	- 1.99
Lead	3.18	7.30	1.40	0.99
Iron	2.19	5.40	1.09	0.30

Abbreviations on Figures

CO = Cord
CS = Calcified septa
CPE = Calcified periostracum
F = Fibrous-like material
PR = Prismatic layer
LA = Lamellar layer

LEGEND OF FIGURES

Figs. (1,2,3 and 4): Scanning electron micrographs of preostracum wings and the siphuncle in adult *Sepia officinalis*. X 15, x 200 and x 75.

Fig.. (5): Scanning electron micrographs of phragmocone septa in phragmocone chambers. X 75.

Figs. (6,7 and 8): Scanning electron micrographs of the outer periostracum layer. X 150,x2000 and x 2000

Figs. (9 and 10): Scanning electron micrographs of the middle prismatic layer.X100 and x1000.

Fig. (11): Scanning electron micrographs of the shape of calcium crystals in the prismatic layer. X 500.

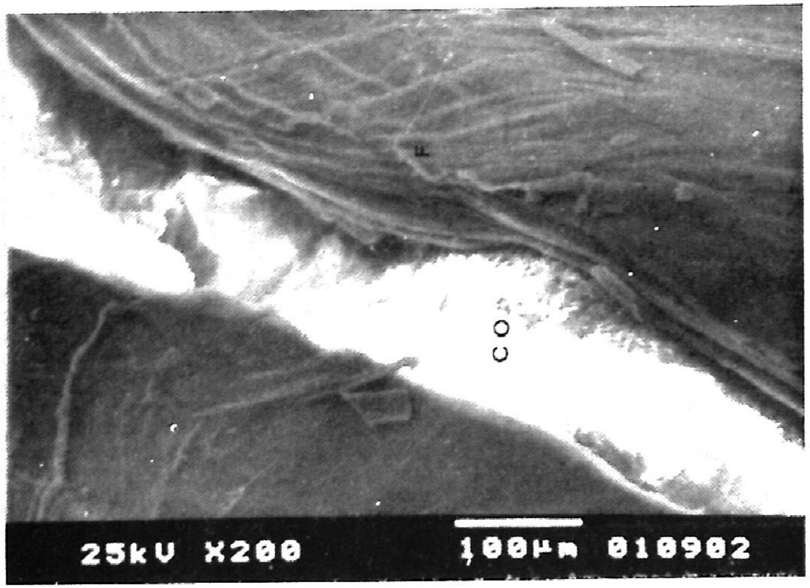
Fig. (12): Scanning electron micrographs of the last Lamellar layer. X35.

Fig. (13): Distribution of elements in the outer layer of the juvenile shell of *Sepia officinalis* .

Fig. (14): Distribution of elements in the inner layer of the juvenile shell of *Sepia officinalis*.

Fig. (15): Distribution of element in the outer layer of the adult shell of *Sepia officinalis*

Fig. (16): Distribution of elements in inner layer of the adult shell of *Sepia officinalis*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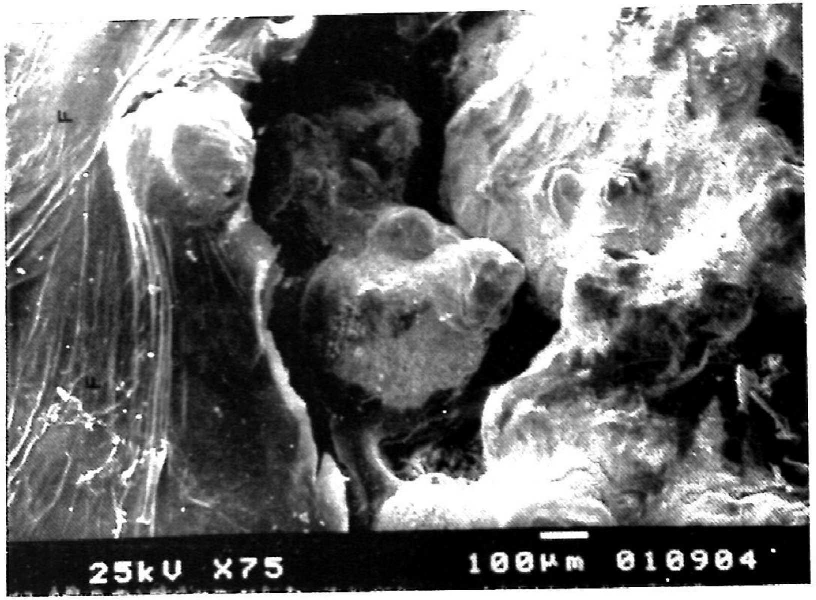
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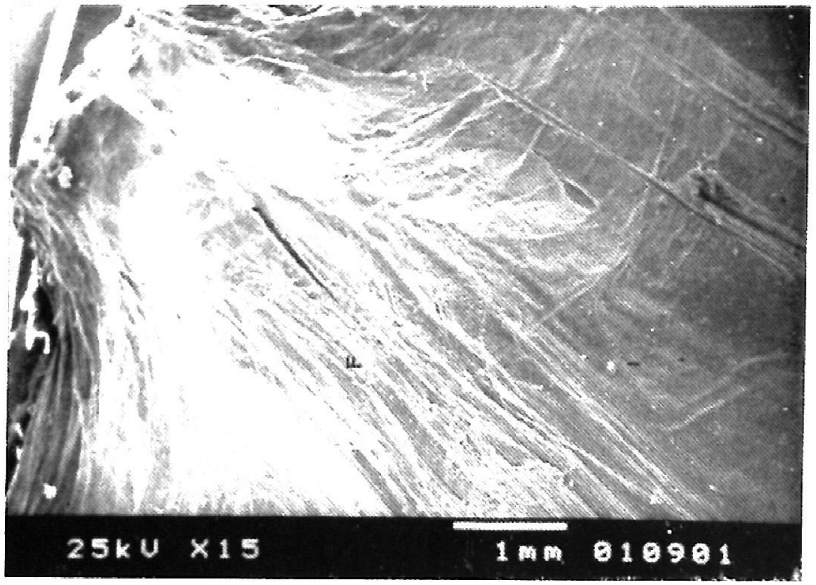
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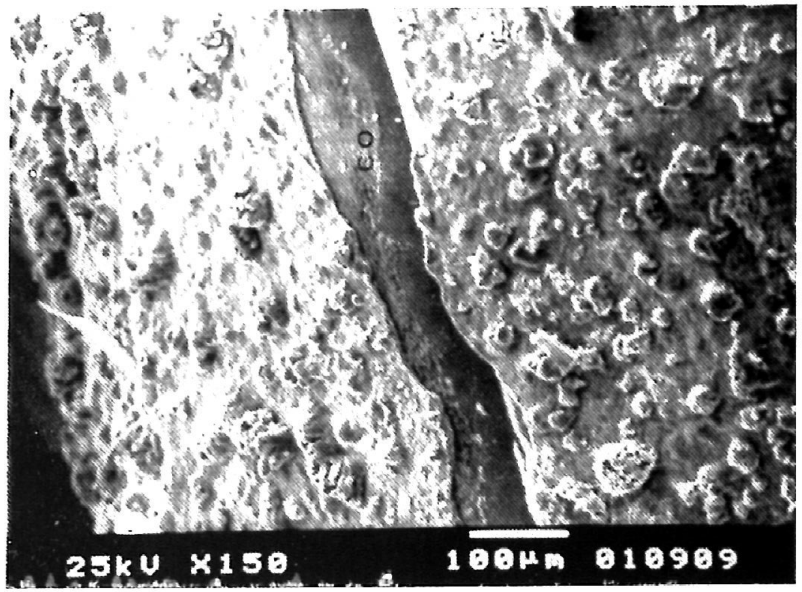
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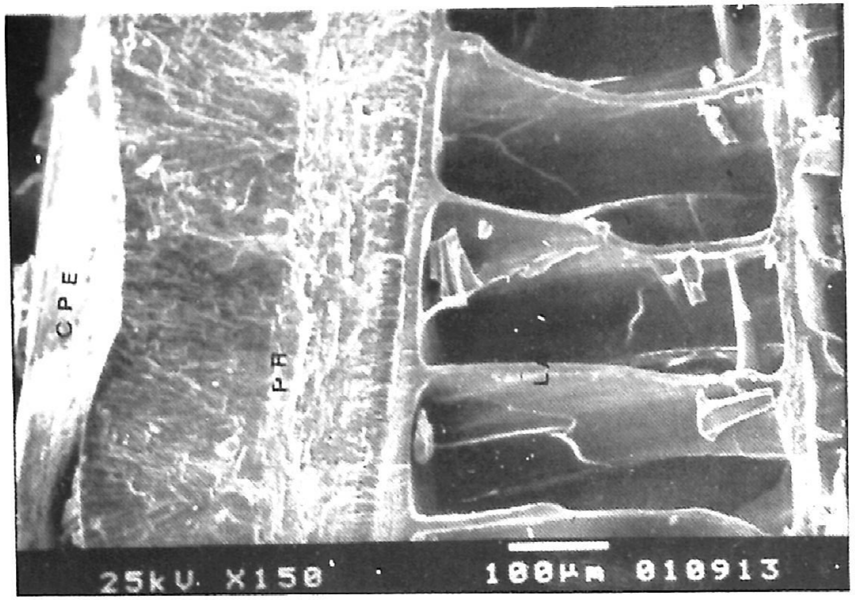
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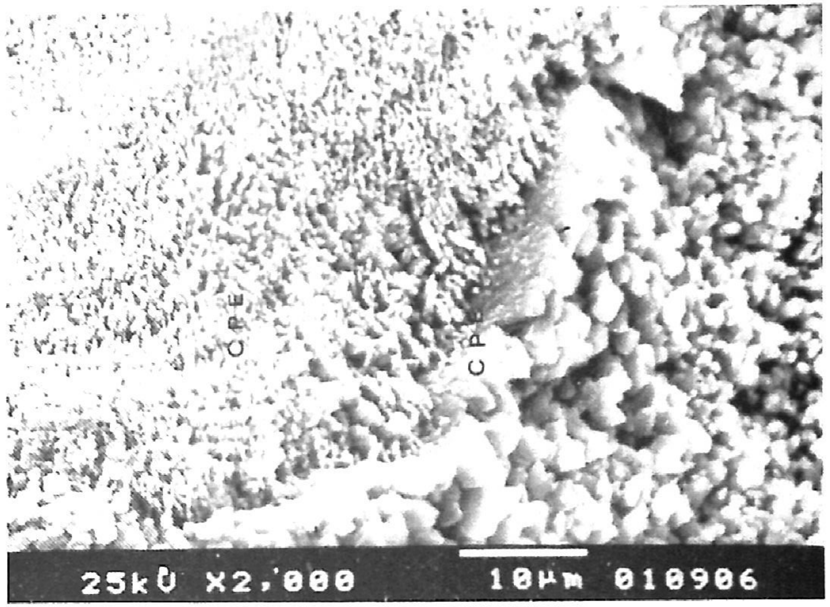
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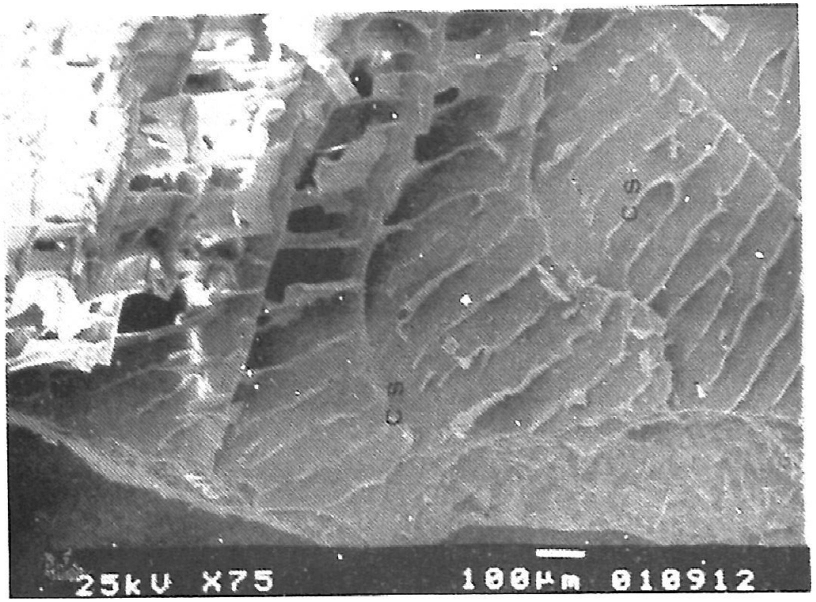
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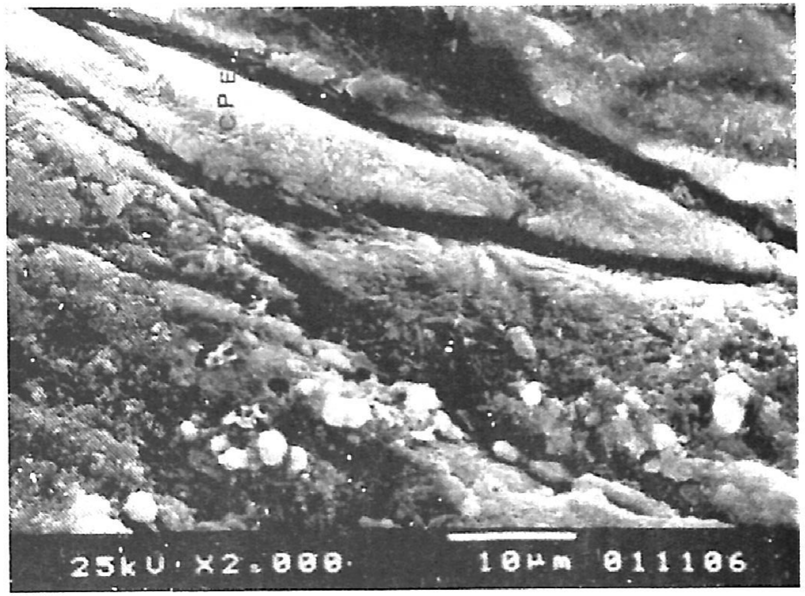
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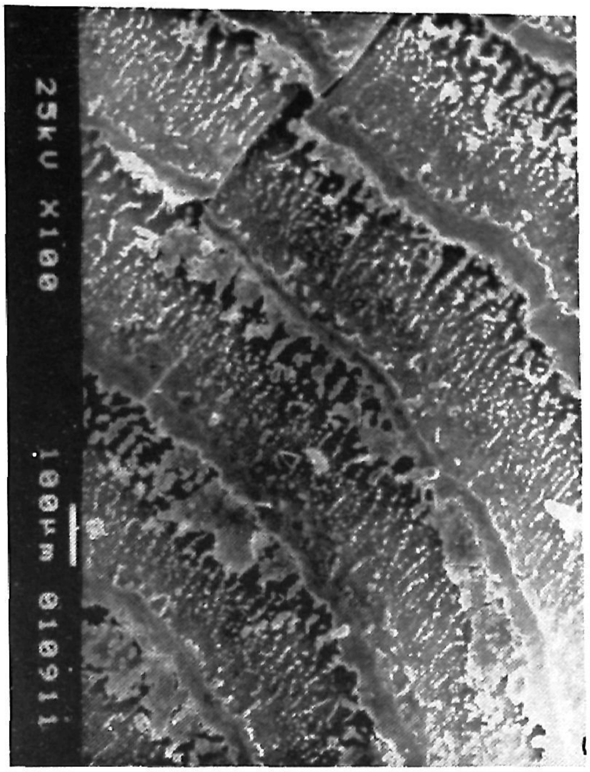
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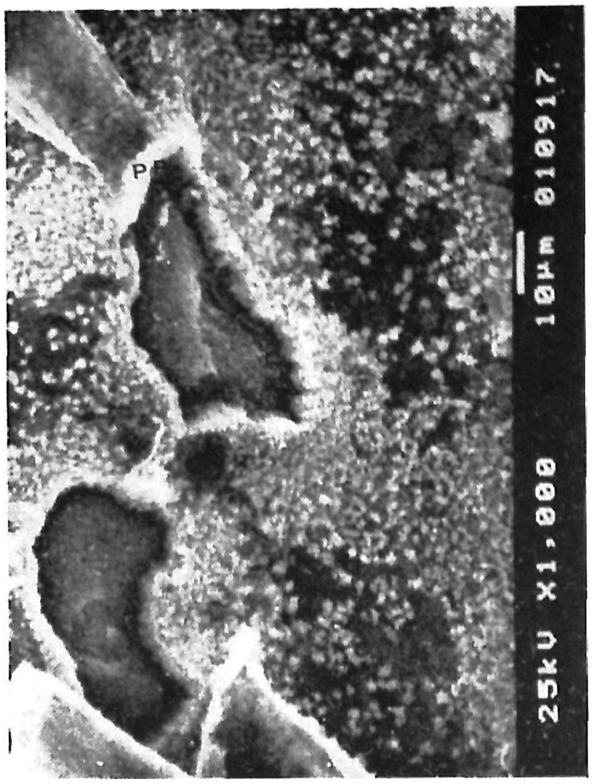
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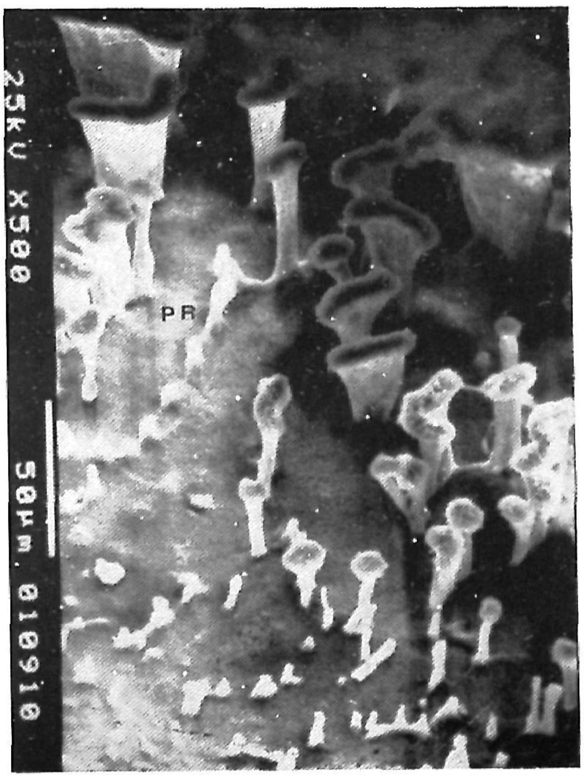
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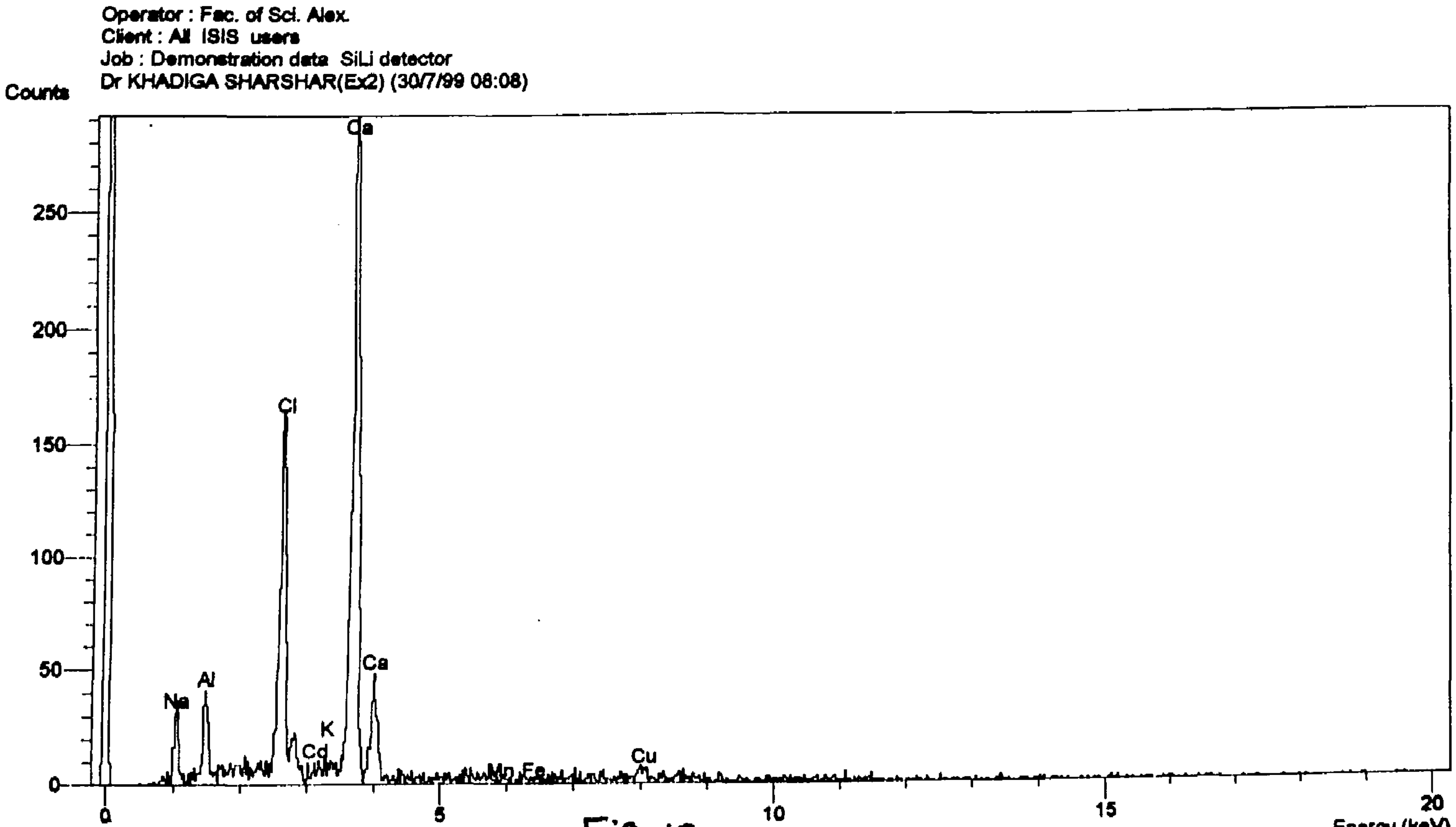
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100
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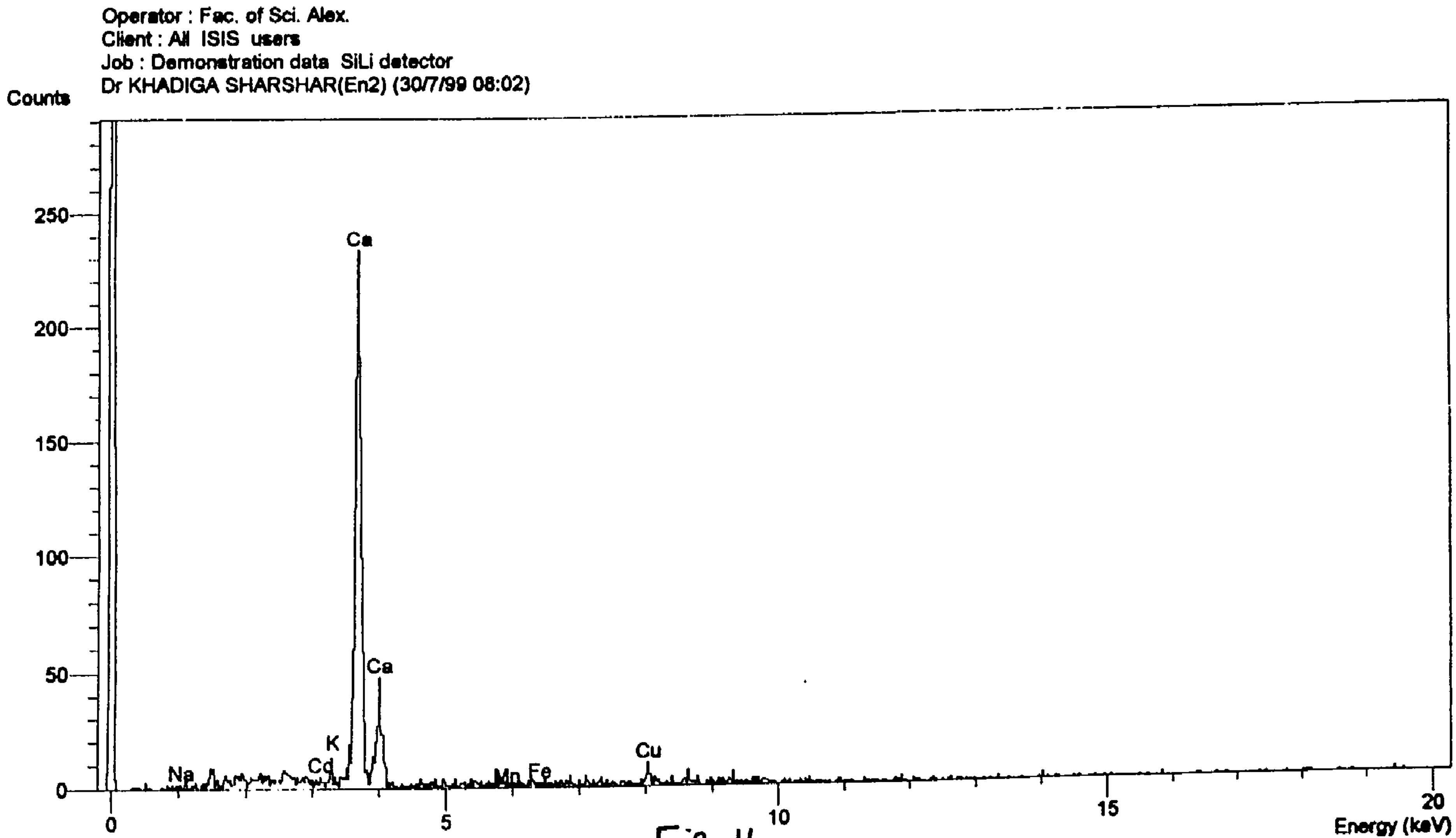
Al
Na
K
Cd
Mn
Fe
Cu
0
5
10
15
20
Energy (keV)

Fig. 13



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Energy (keV)

Fig. 14

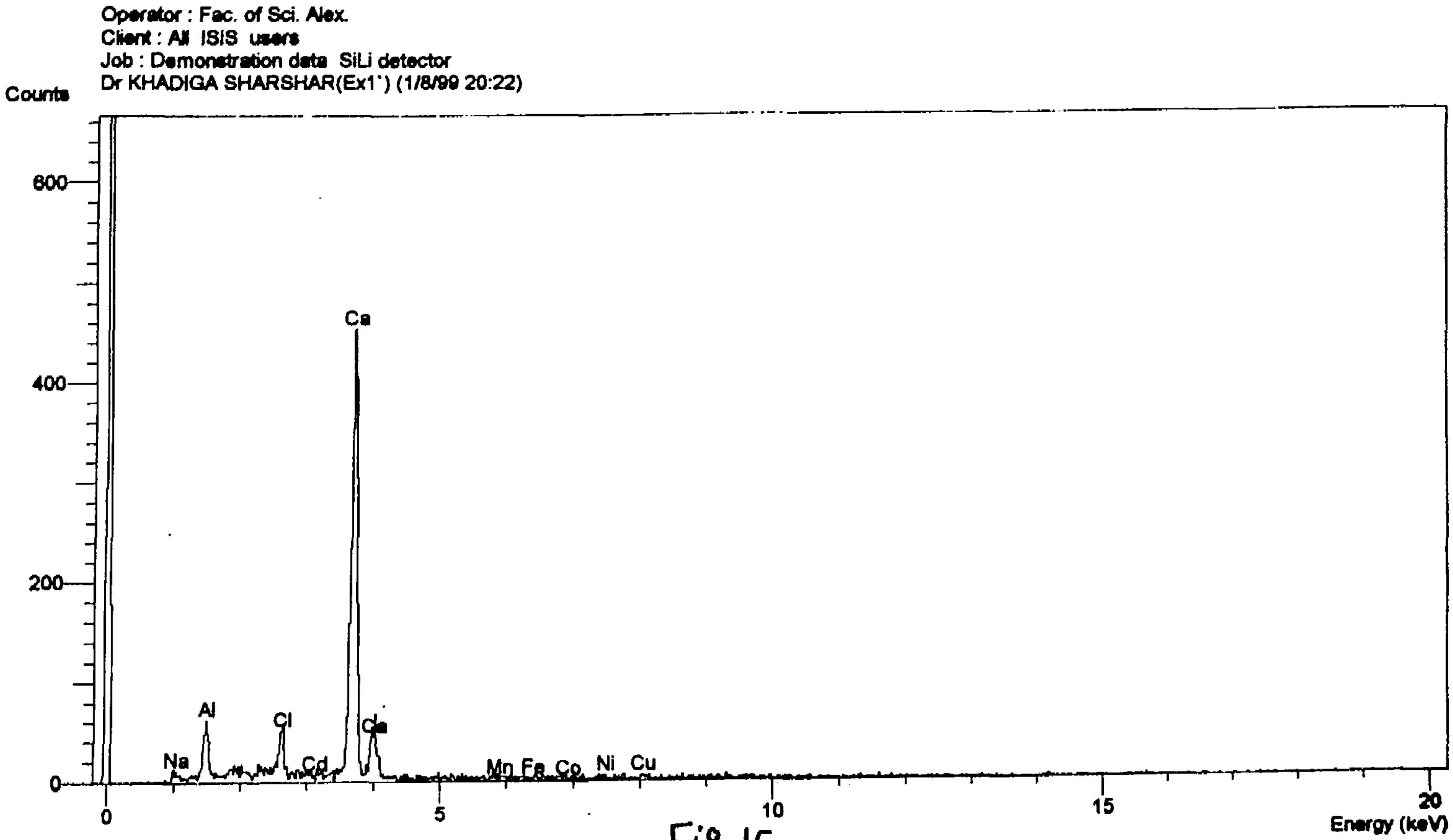
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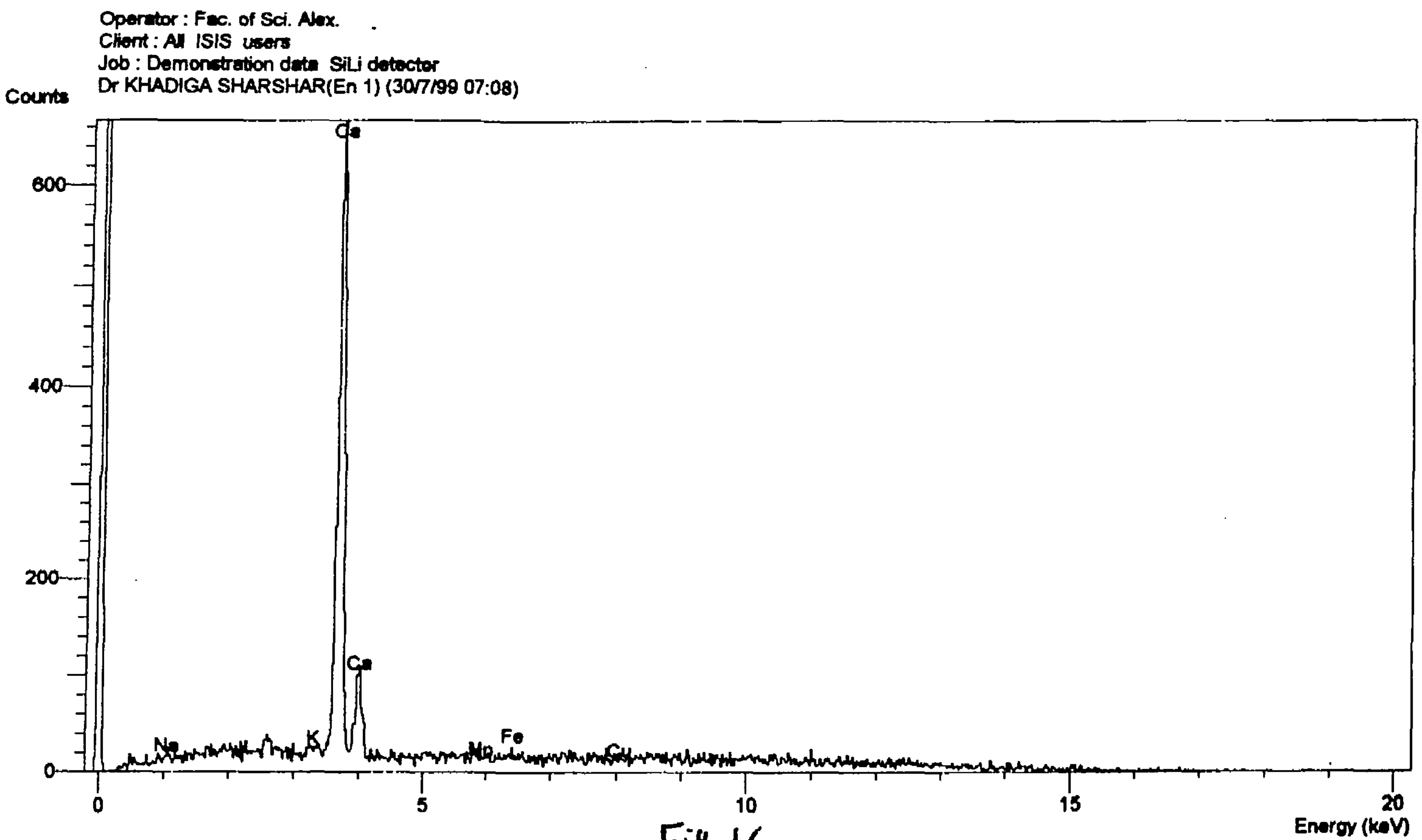
Fig. 15



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Energy (keV)

Fig. 16