

IMPACT ON HEALTH BY NANOPARTICLES CREATED BY HIGH-TEMPERATURE EXPLOSIONS

Antonietta M. Gatti, Stefano Montanari*

Laboratory of Biomaterials – University of Modena and Reggio Emilia – Italy

*Nanodiagnosics srl – Modena - Italy

Introduction

Combustion processes create a form of particulate pollution that can be released into the environment. The size of the particles mostly depends on the temperature the process has happened, while their chemistry depends on the materials present at combustion. The higher the temperature, the smaller those particles are. As a consequence of the explosion of Depleted Uranium bombs, the temperature in a certain neighbourhood exceeds 3,000 °C, as already described back in 1978 by the researchers working at the US Army Base of Eglin (Florida), who discovered the presence of inorganic micro- and nano-particles polluting the environment after explosion tests had been carried out. Without being able to supply any scientific demonstration, they advanced the hypothesis that that kind of pollution could be dangerous to humans if inhaled or ingested. Aim of this work has been to verify that hypothesis through the detection of that micro- and nano-sized particulate matter in sick people who took part in the latest war in former Yugoslavian territories and contracted the so-called Balkans Syndrome.

Materials and Methods

Twenty cases of Italian soldiers and 8 cases of civilians living in Sarajevo at the time when the war was fought were examined. Those patients suffered from Hodgkin's and non-Hodgkin's lymphomas or different forms of cancer. The samples come to our observation regarded pathologies of the lymph nodes, the liver, the kidneys, the stomach and the lungs. Through an innovative technique of Environmental Scanning Electron Microscopy (ESEM), particles were actually consistently detected in all those patients' pathological tissues. An elemental analysis of the particles was carried out through a method of Energy Dispersion Spectroscopy (EDS). The instrument employed was an ESEM QUANTA (Fei Company – The Netherlands) which allows to carry out observations on samples virtually whatever their condition is, without wanting metal or carbon coating nor any other form of preparation. Such a possibility is particularly important to this kind of investigation, as no pollutants or artefacts due to preparation procedures can be introduced. The samples checked were either fresh or coming from archived cases. In the latter instance, particular processes to eliminate the paraffin where they had been embedded were used, in order to observe more clearly the morphology and the structure of the biological tissue. The fresh samples were examined under ESEM mode (in air and at -5°C), while the preserved ones were checked in low vacuum conditions (1-4).

Results

All samples observed showed the presence of micro- and/or nano-foreign bodies. No traces of particulate Uranium were ever detected. The particles found in the lungs and

the stomach, i.e. the organs through which the polluting debris enter the organism, were considerably larger in size than those detected in the other organs. The chemistry was extremely varied and, in many instances, relatively complex: Pb was rather common, but Fe, Co, Sb, Zr along with other inorganic elements were present as well.

Discussion

All particles were very small, often nano-sized, and in most cases their shape was spherical, thus indicating a formation under high-temperature conditions. Such conditions are compatible with those induced by high-technology weapons. The temperature above 3,000 °C typical of Depleted Uranium (or Tungsten) projectiles is enough to have bomb and mark sublime and create an aerosol containing the elements present in the "crucible" of the explosion. Those elements can recombine and form new alloys or compounds. The particles thus created can stay suspended in the atmosphere for hours or even days and be transported by the wind. During that time, they can be inhaled by men and animals alike. Then they fall very slowly to the ground and deposit on grass, vegetables, fruit, etc. whence they enter the alimentary chain. It is also likely that the rain can have those particles penetrate the earth and enter springs and subterranean waters.

It has already been demonstrated (5) that particles the size of 100 nm, when inhaled, enter the blood flow within 60 seconds and are found in internal organs in a matter of minutes.

As the majority of the particles found contained heavy metals, whose toxicity and cancerogenicity is already amply described in literature, a correlation between their presence in all pathological tissues investigated and the onset of the disease is very probable.

The fact that no Uranium was found does not necessarily mean that there isn't any within the organism of the patients. It might have reached tissues that showed no pathological features and, for that reason, were not sent to our Laboratory.

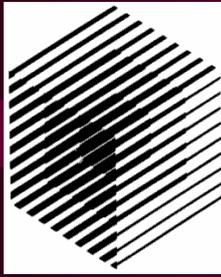
The evidence of particulate matter in human tissues able of triggering the onset of what until now are classified as "cryptogenic" diseases lead to set the foundations of a new discipline called "Nanopathology".

Acknowledgements

This research was supported by the European Community (Nanopathology QLRT-2002-147).

References

- 1) A.M. Gatti , F. Rivasi Biomaterials 23(11), 2381 (2002).
- 2) A.M. Gatti Biomaterials. 25(3), 385 (2004)
- 3) A.M Gatti. Transactions of the 28th annual meeting in Biomaterials, Tampa (Florida) (2002), p.616.
- 4) A. M. Gatti, S. Montanari <http://members.xoom.virgilio.it/larchivio/sindromebalcani.htm>, 8-2-2004
- 5) A. Nemmar, B. Vanquickenborne, M.F. Hoylaerts, B.Nemery, Circulation, 105(4), 411 (2002).



European Commission

**Istituto Nazionale
per la Fisica della Materia**



**Università degli Studi di Modena
e Reggio Emilia**
LABORATORIO DEI BIOMATERIALI



Nanodiagnostics

Impact on health of nanoparticles created by high temperature explosions

Antonietta M. Gatti, Stefano Montanari *

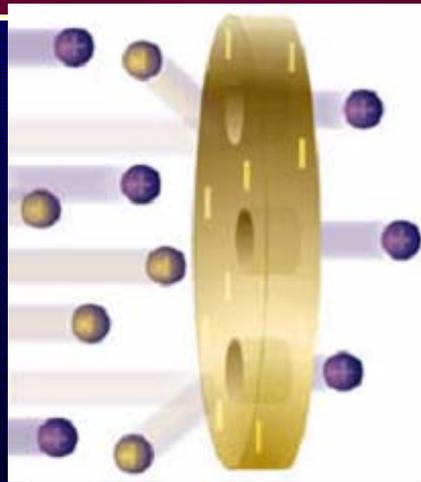
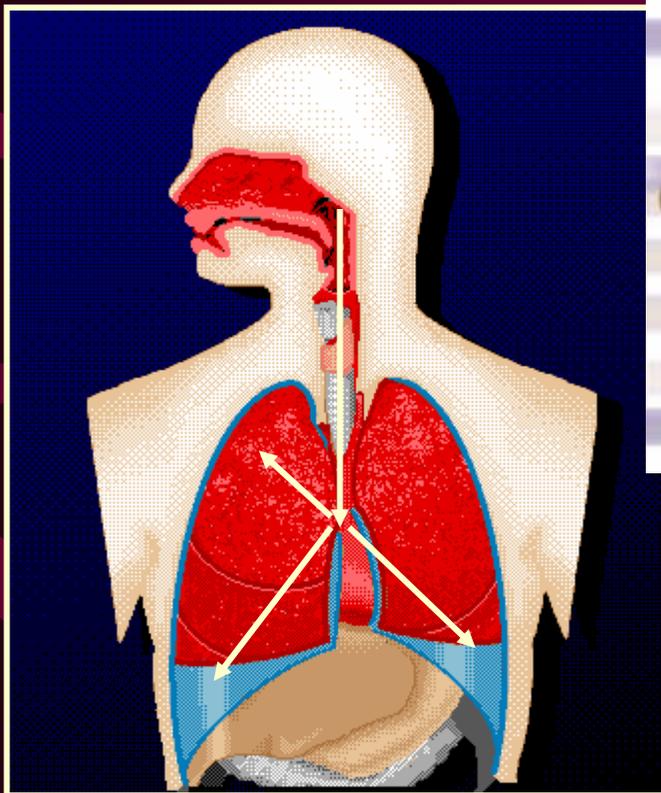
Laboratory of Biomaterials, University of Modena, Italy

*Nanodiagnos

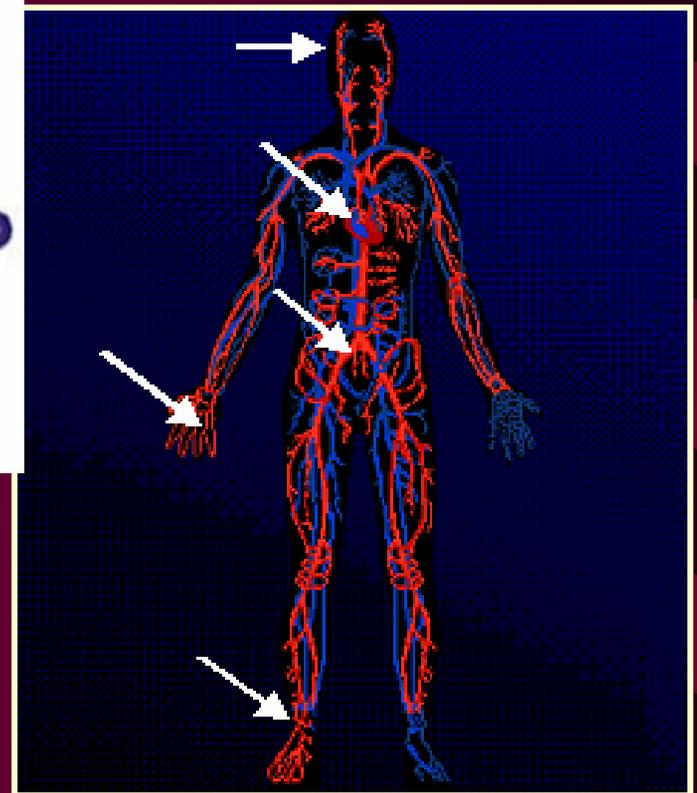
tics, Italy

How nanoparticles enter the human body

Respiratory system



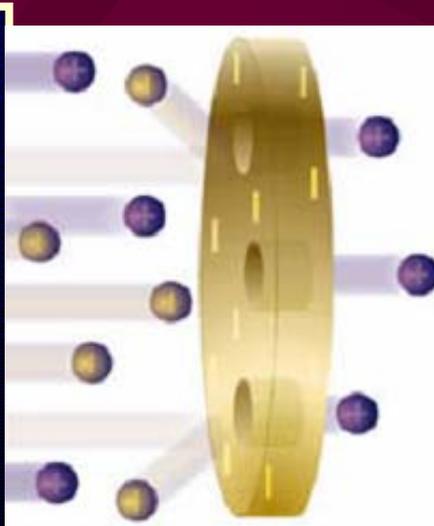
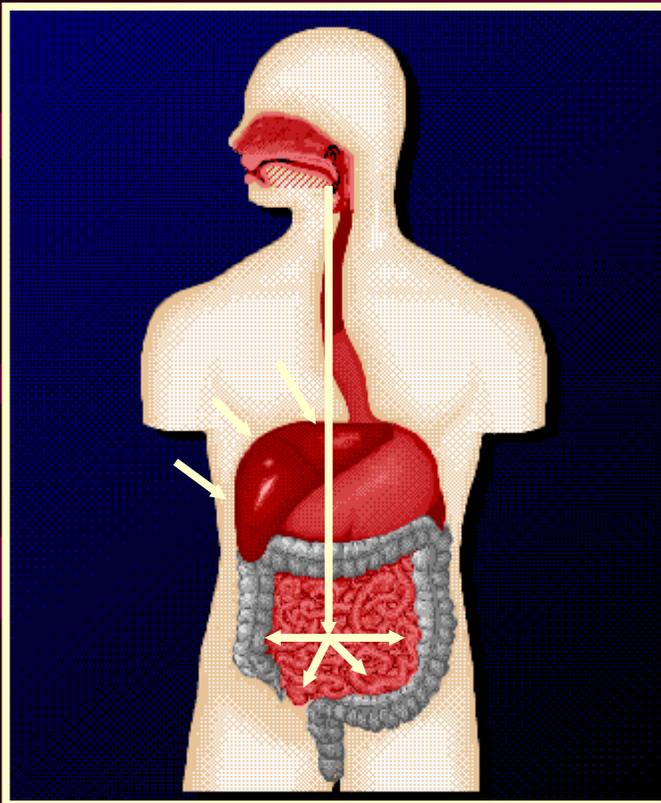
Blood circulation



Environmental pollution

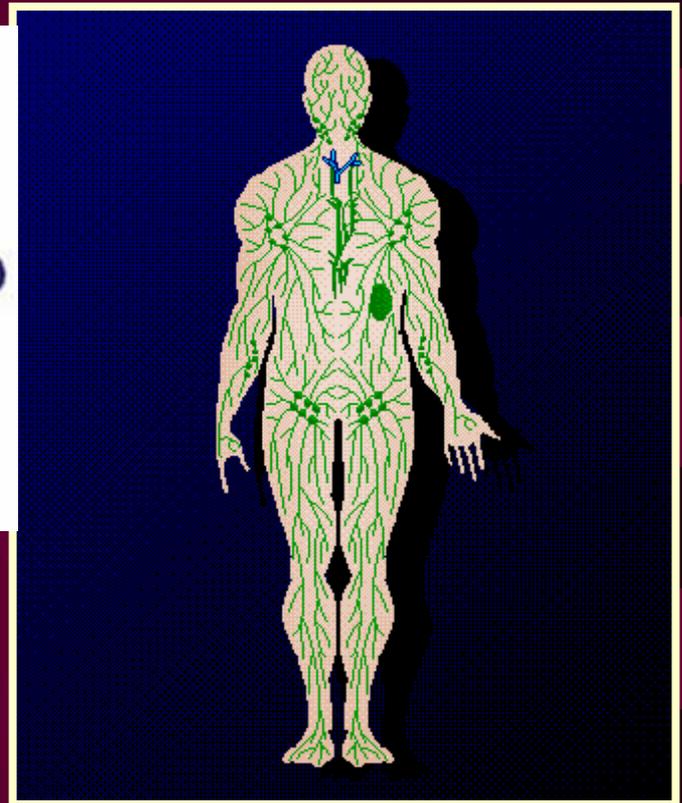
How nanoparticles enter the human body

Digestive system



Polluted food

Lymph circulation





Università degli Studi di Modena e Reggio Emilia
Dipartimento delle Neuroscienze, Testa e collo, Riabilitazione
LABORATORIO DEI BIOMATERIALI



European Project “NANOPATHOLOGY” (QOL-2002-147)

Coordinator Dr. A. M. GATTI

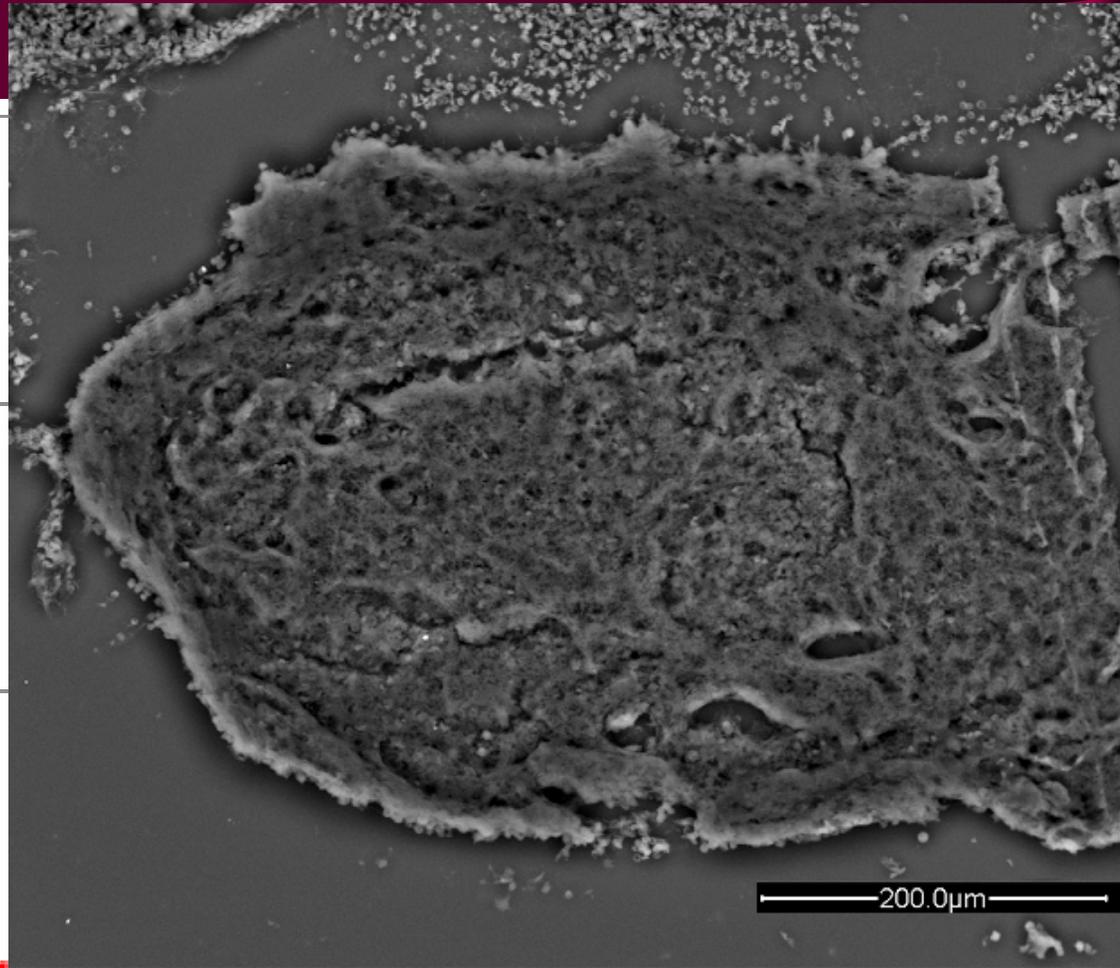
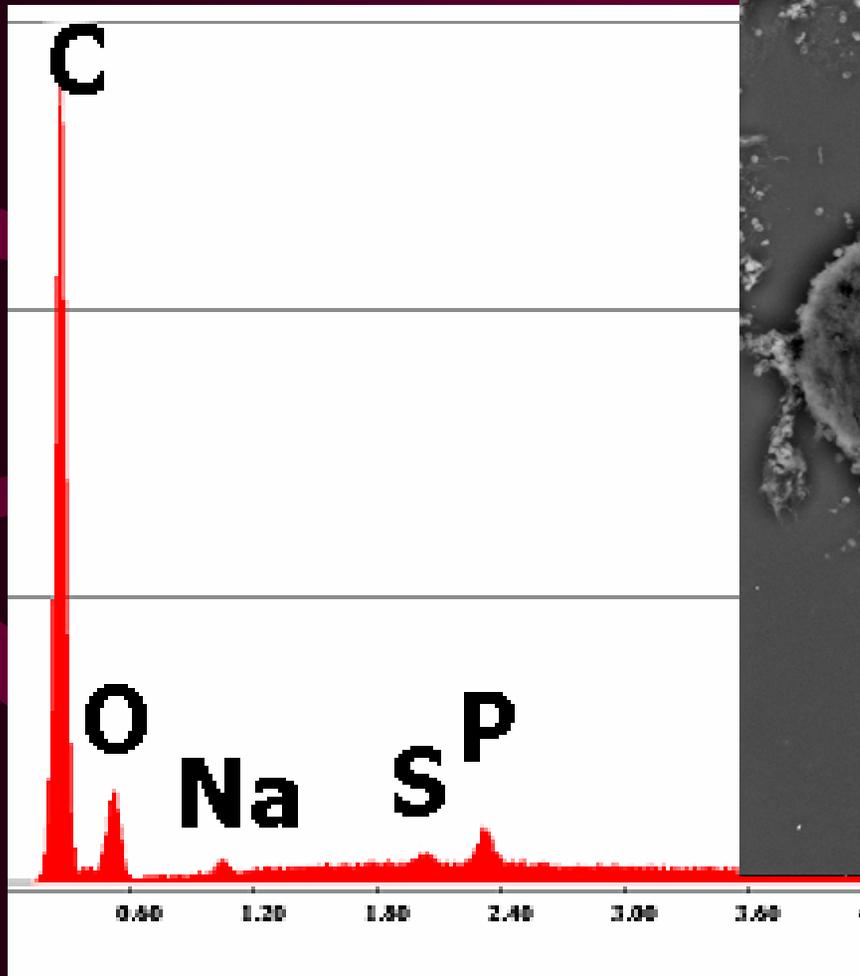
Partners: Univ. of Cambridge, of Mainz, FEI company, Biomatech

Innovative technique of:

- Environmental Scanning Electron Microscopy
- Energy Dispersive Spectroscopy



Cross section of a thrombus formed in vivo at low magnification with the EDS spectrum of the elements



Reference tissue

Nanopathologies in soldiers

exposed to war environmental pollution

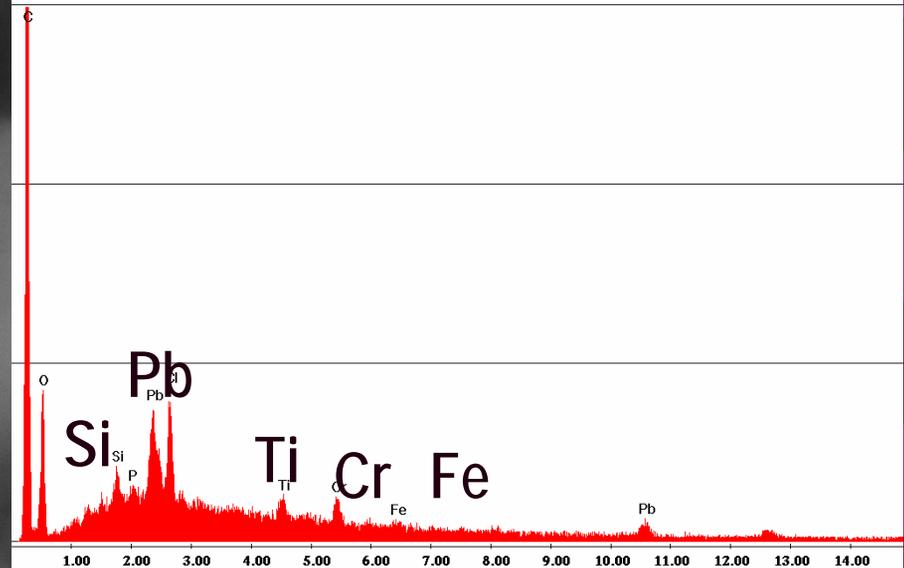
Investigated tissues:

- Lung
- Liver
- kidney
- Bladder
- Lymph nodes
- Sperm

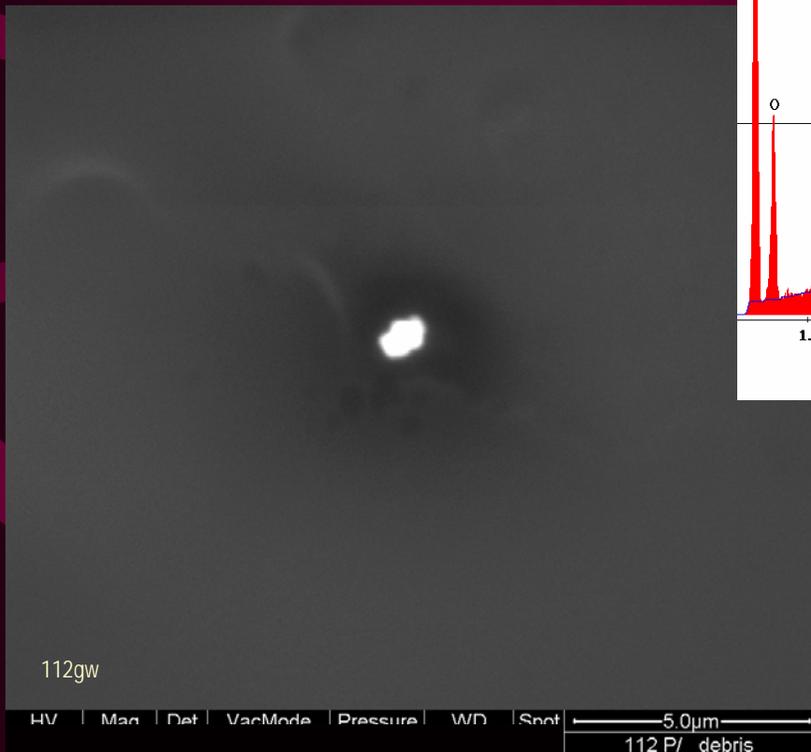
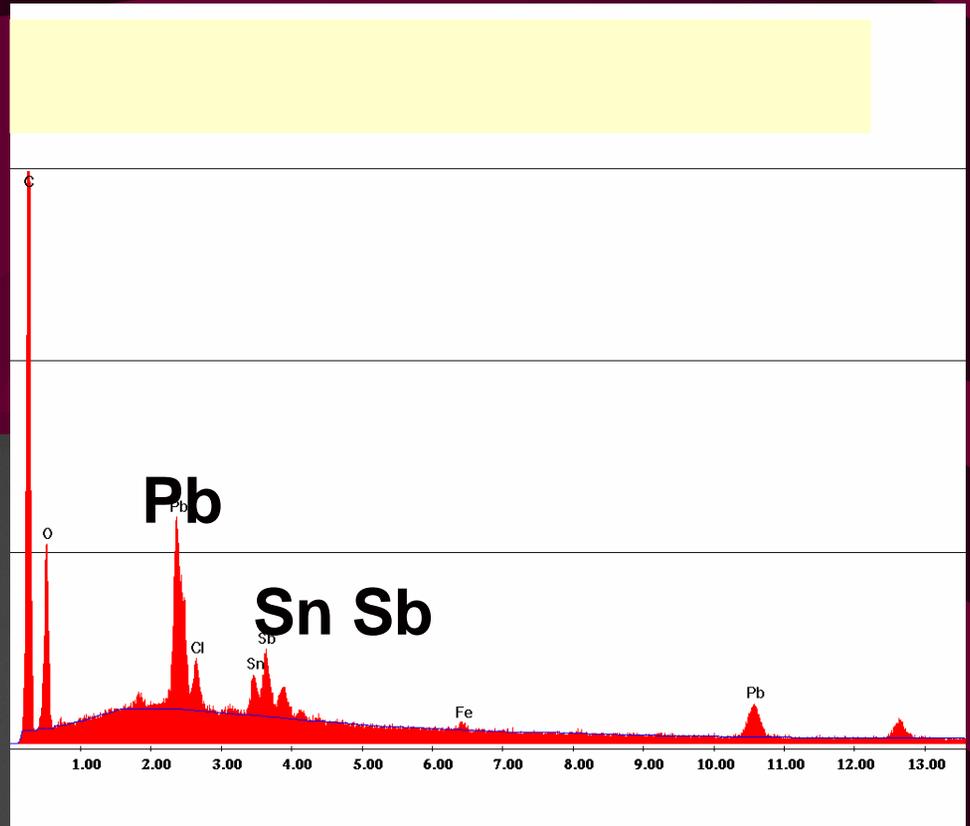
Autoptic sample of a soldier's lung affected from the Gulf War Syndrome.



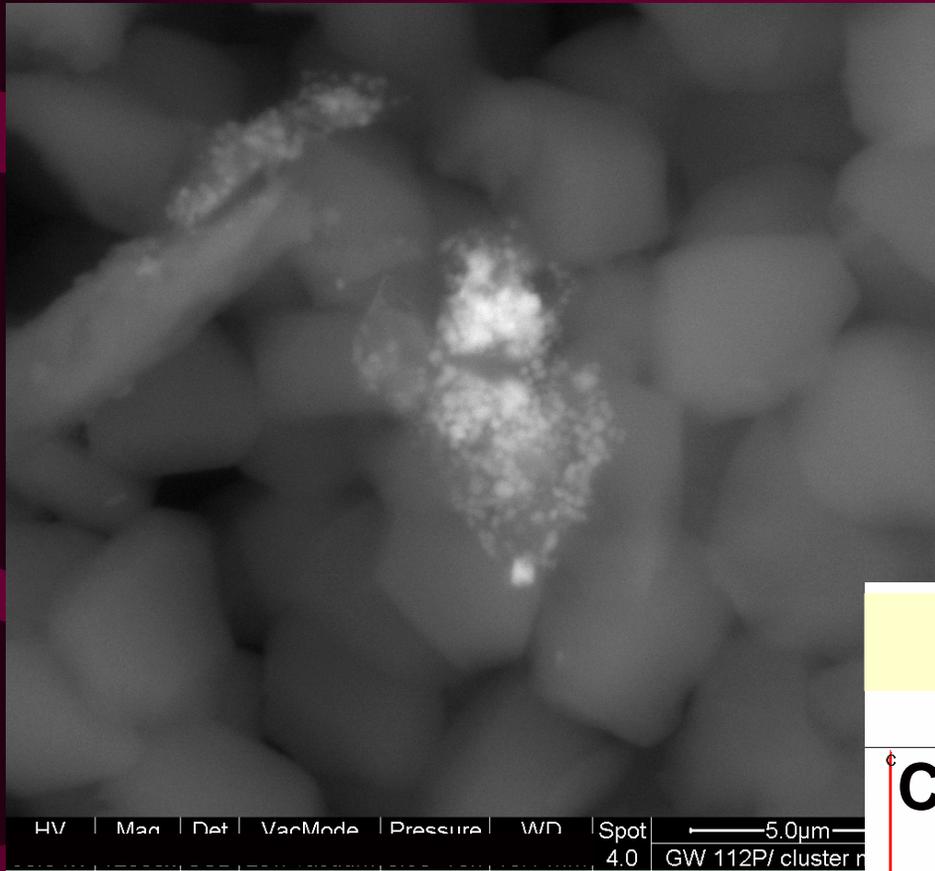
Spectrum of the cluster of nanodebris in the lung



Gulf War Syndrome

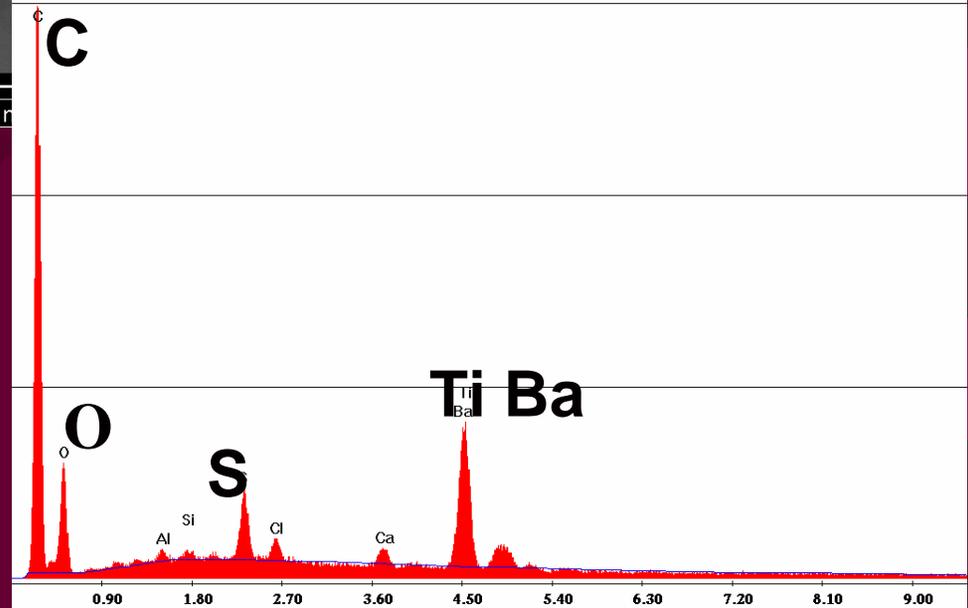


Gulf War Syndrome

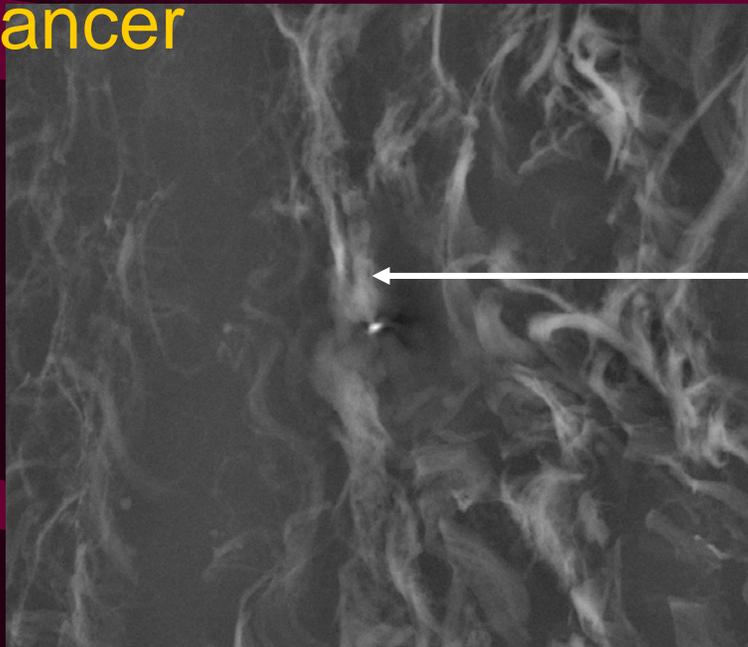


HV | Mag | Det | VarMode | Pressure | WD | Spot | 5.0 μm
4.0 | GW 112P/ cluster n

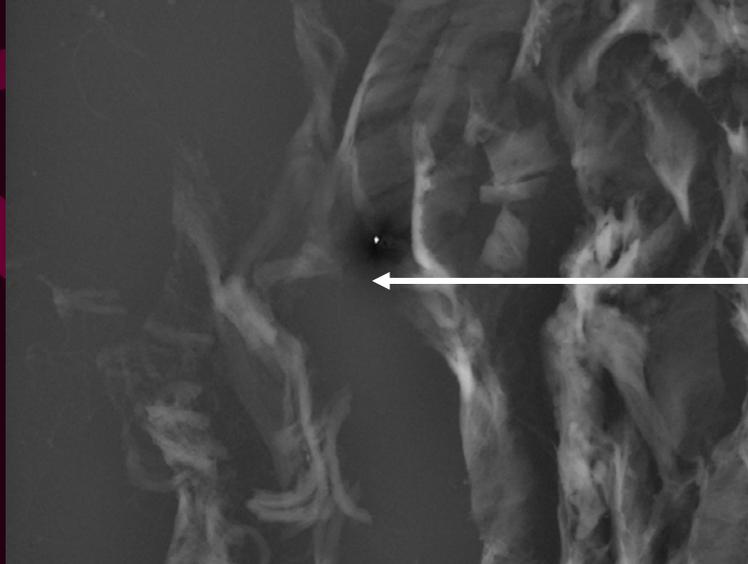
Cluster of nano Ti



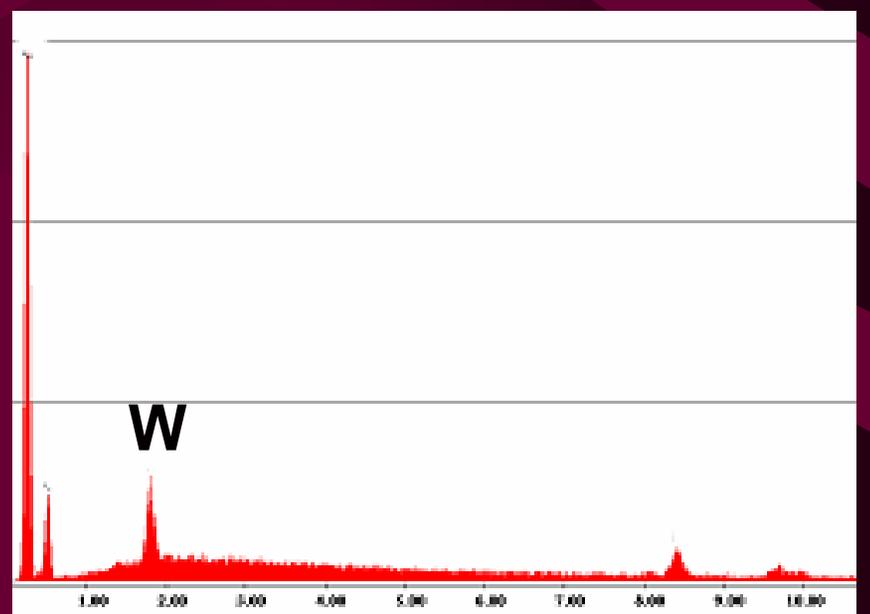
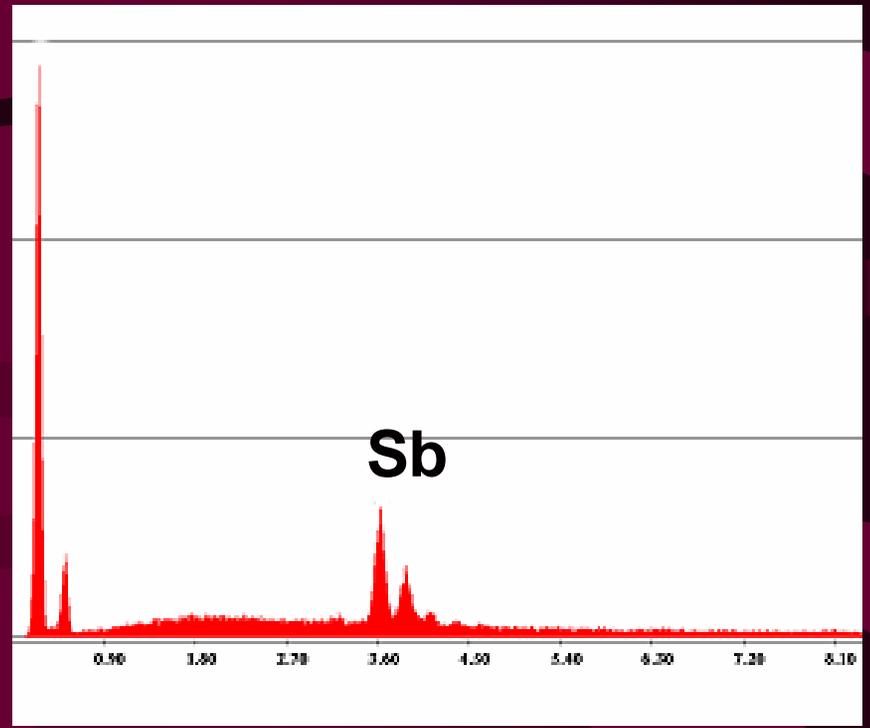
Pleura solitary fibrous cancer



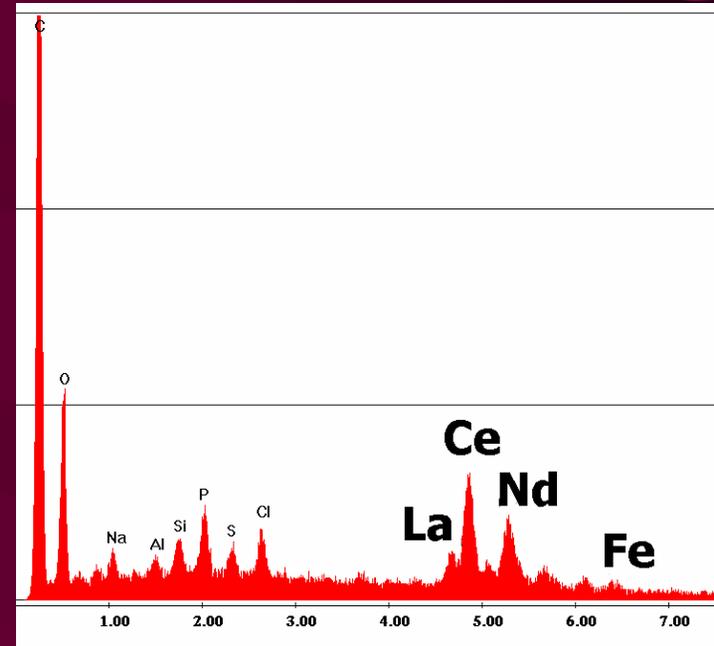
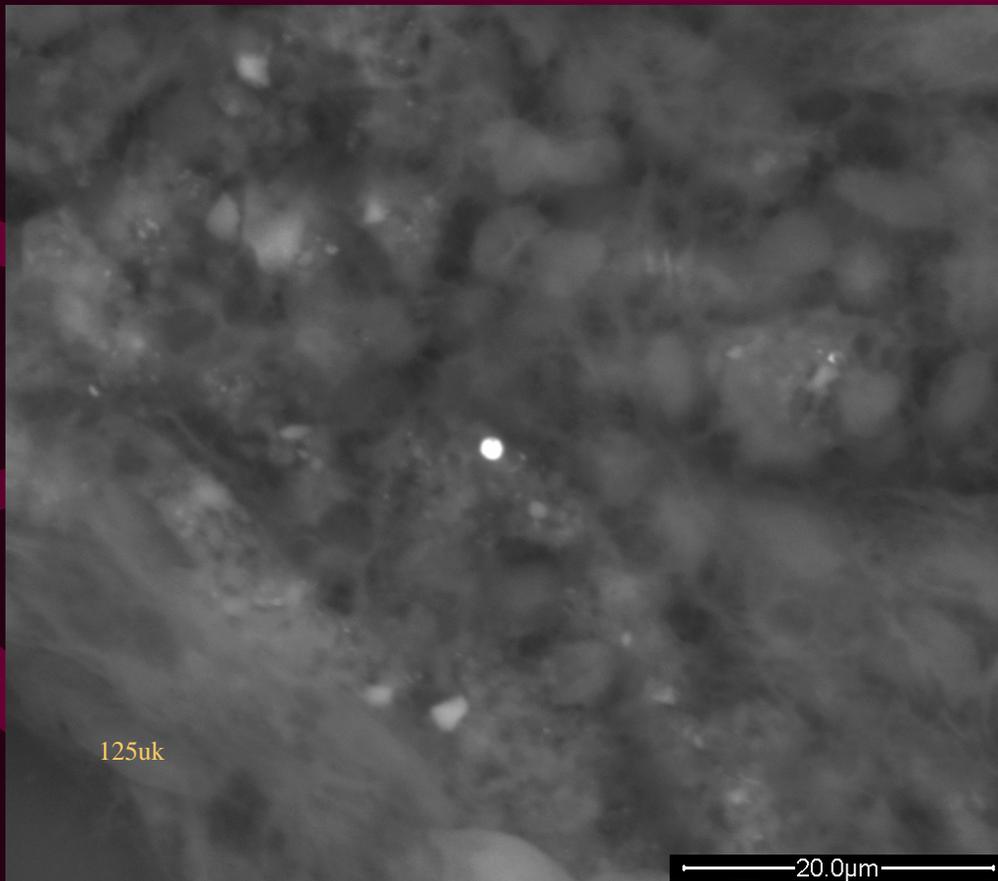
HV	Mag	Det	VacMode	Pressure	WD	Spot	20.0µm
30.0 kV	4000x	SSD	Low vacuum	0.98 Torr	10.0 mm	5.0	66 GW debris Sb



HV	Mag	Det	VacMode	Pressure	WD	Spot	20.0µm
30.0 kV	4000x	SSD	Low vacuum	0.98 Torr	10.0 mm	5.0	66 GW debris W

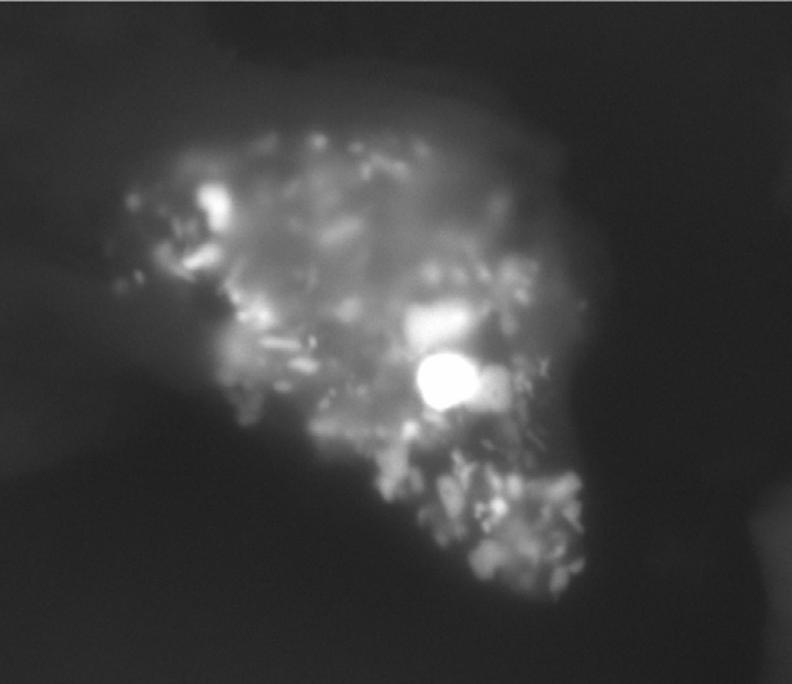
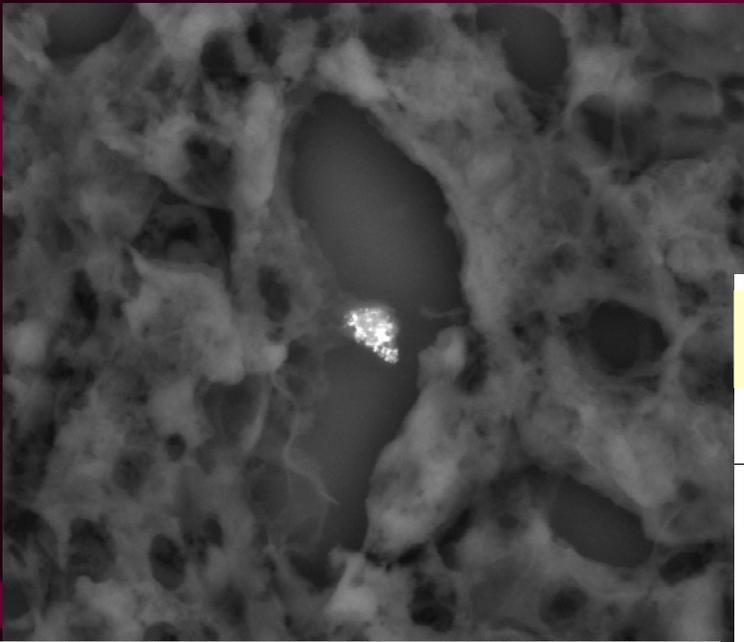
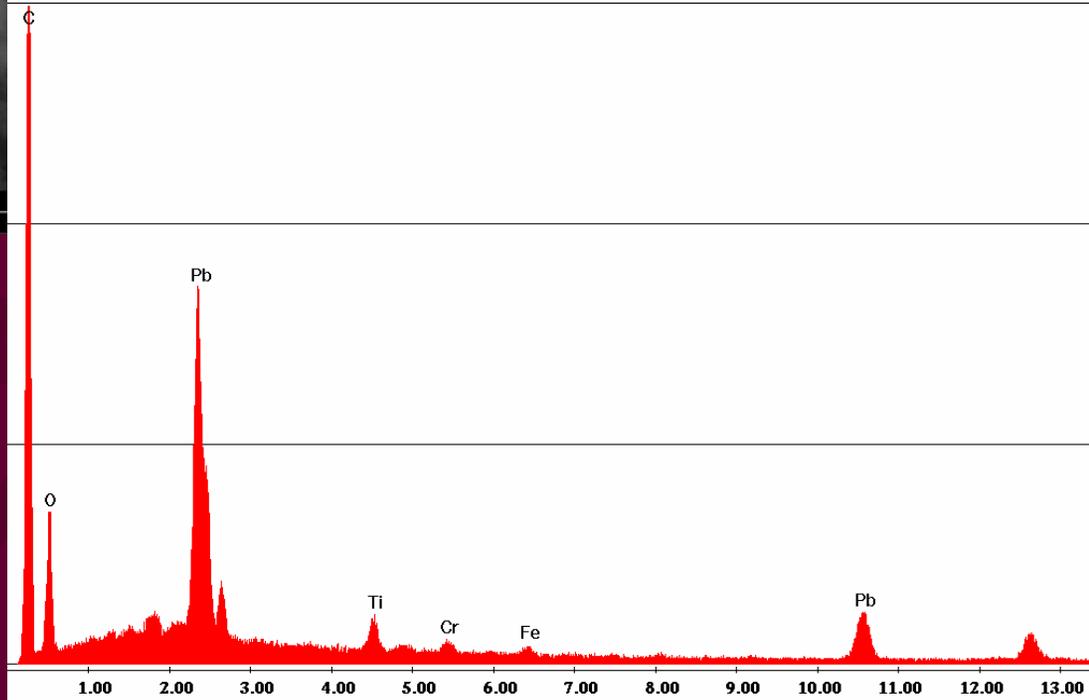


Respiratory system : example of pollution from the combustion of a cigarette



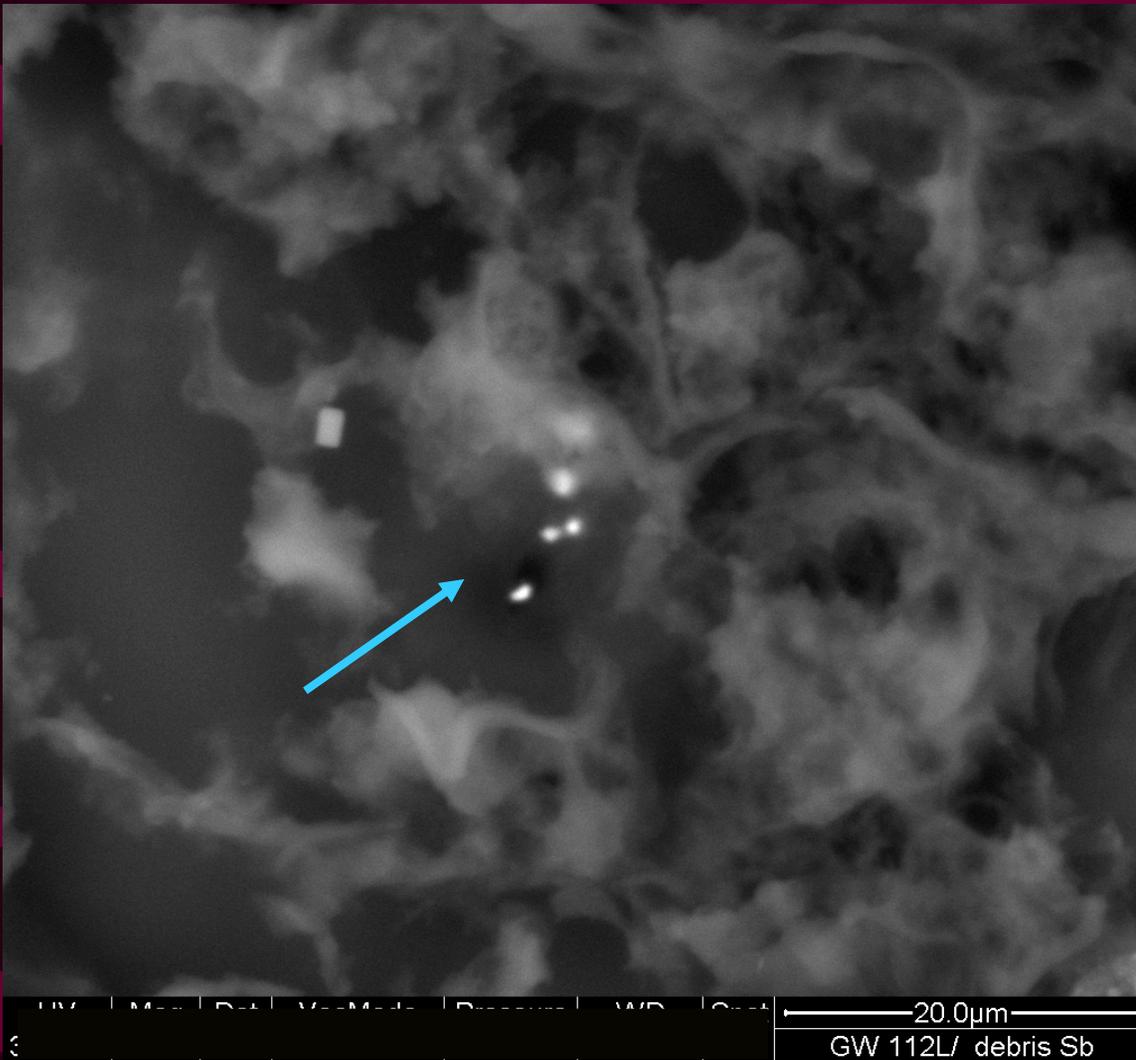
Liver of a GW syndrome

Cluster Pb Ti Cr Fe

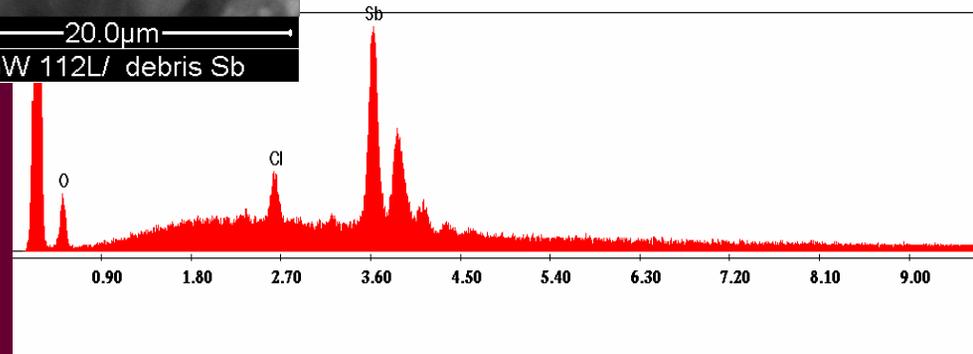


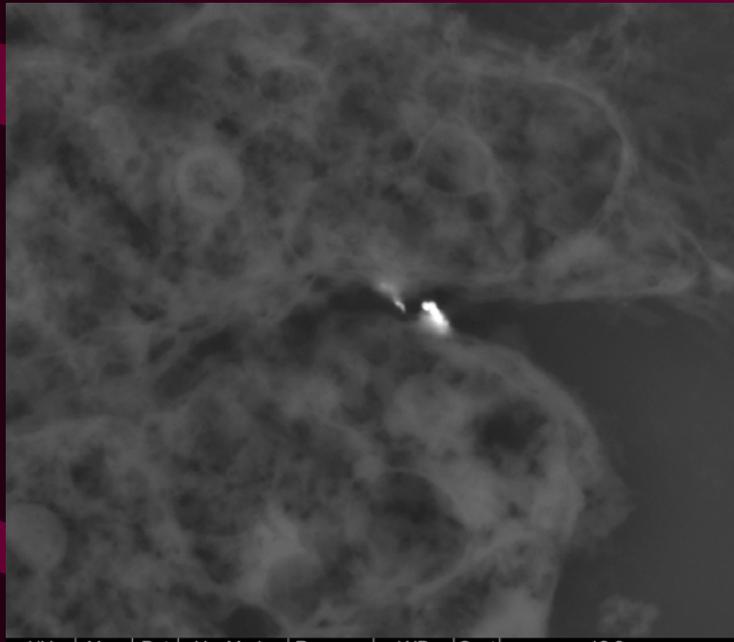
— 2.0 μm —
112 L / cluster nano Pb

Gulf War Liver

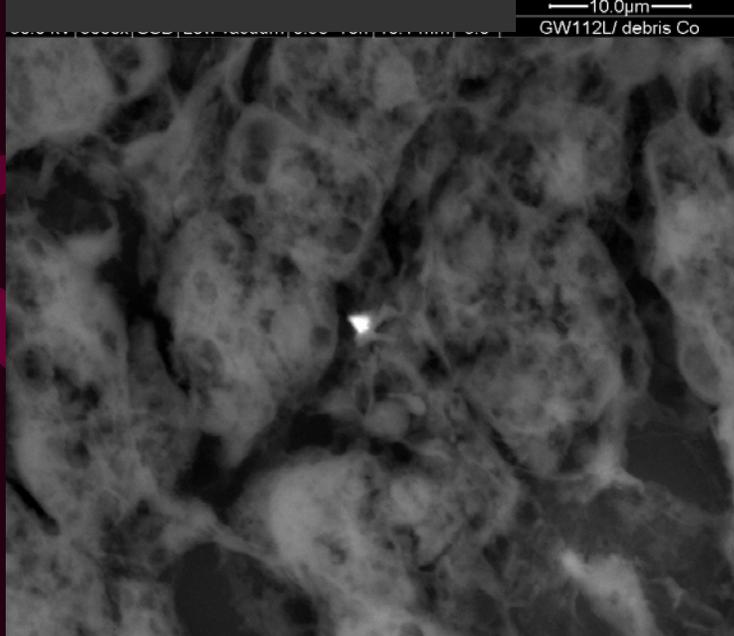
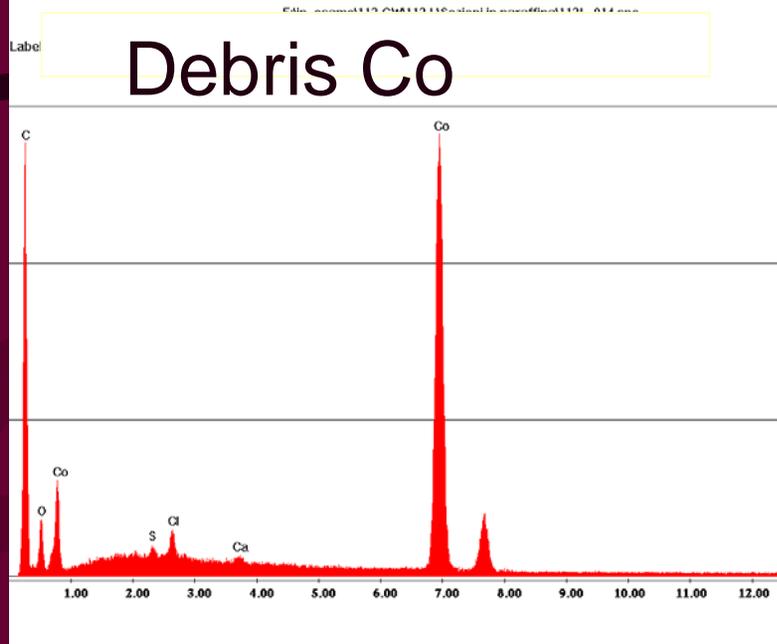


Sb

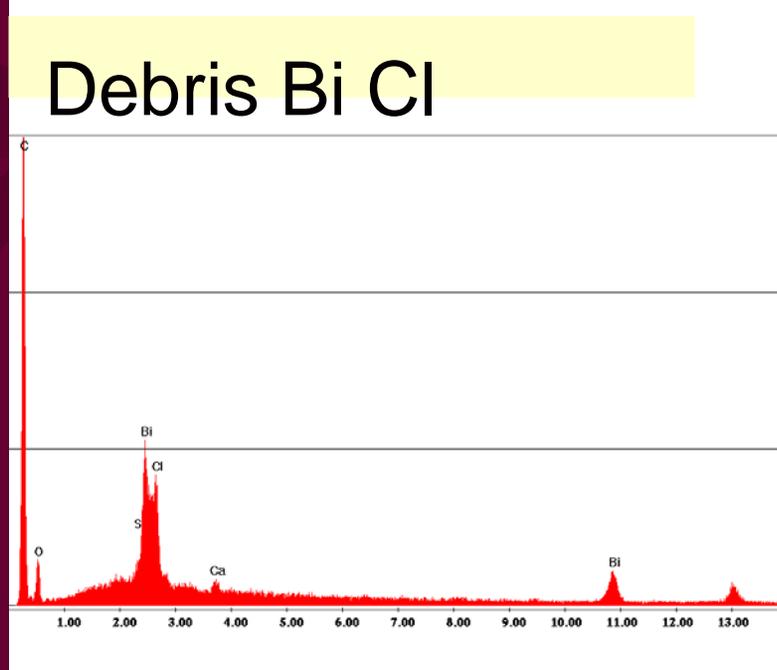


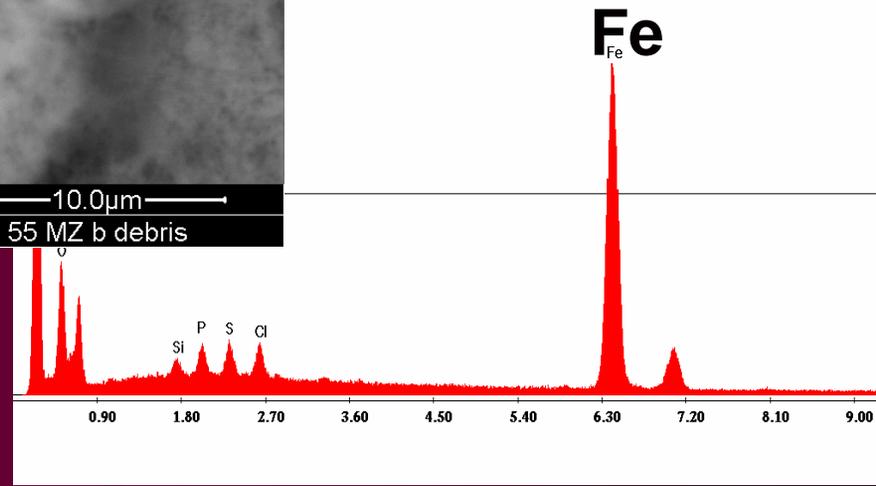


10.0 μm
GW112L/ debris Co



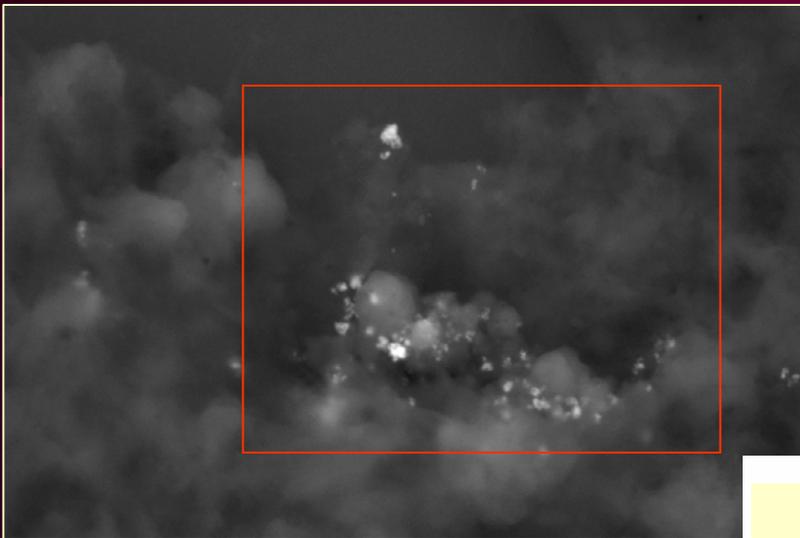
20.0 μm
GW 112L/ debris Bi Cl



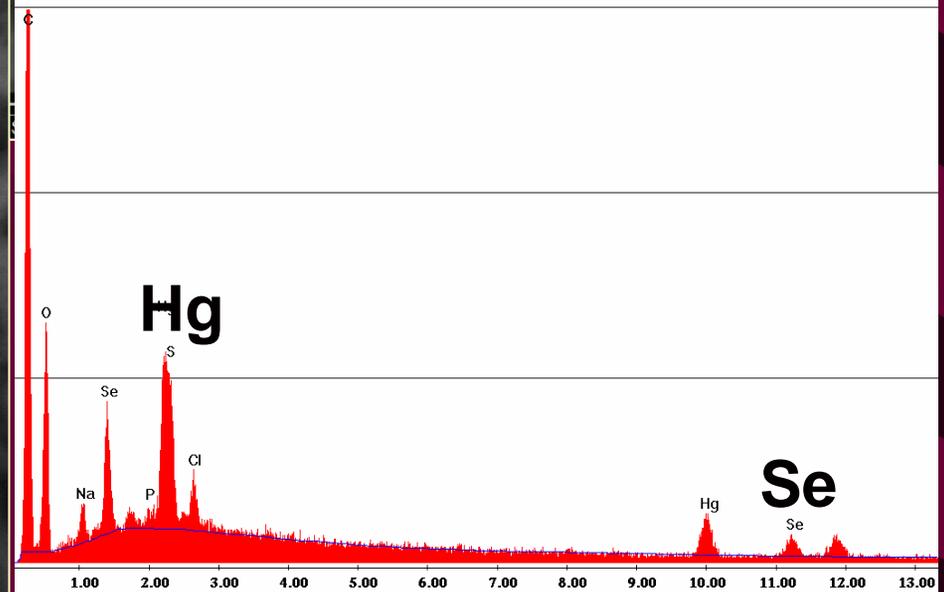
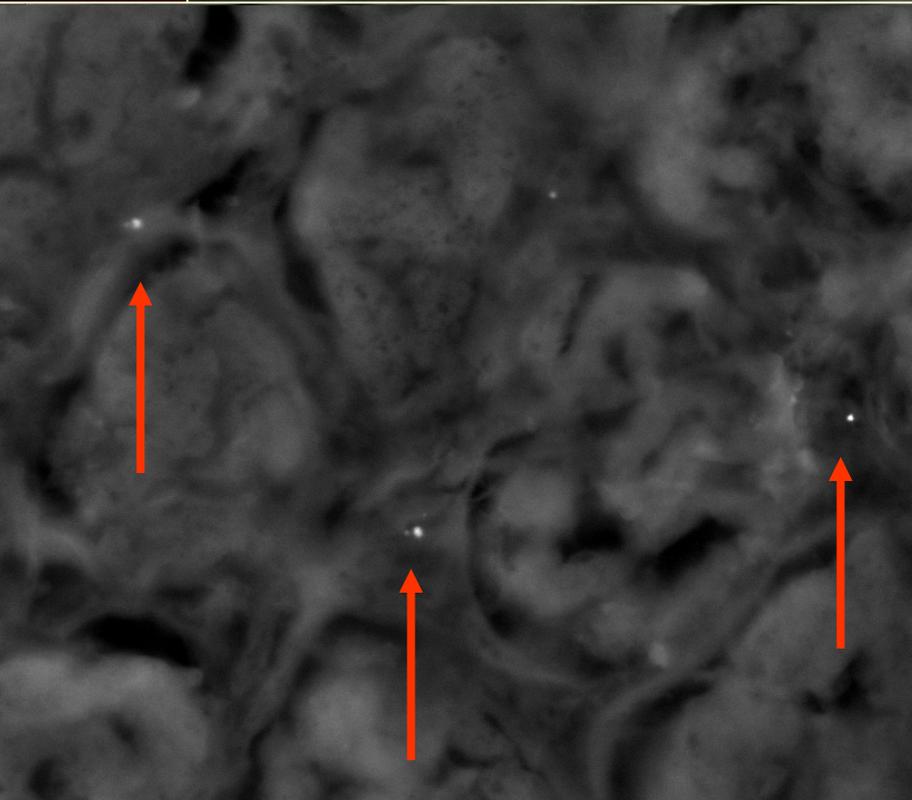


Liver cancer

Gulf War kidney



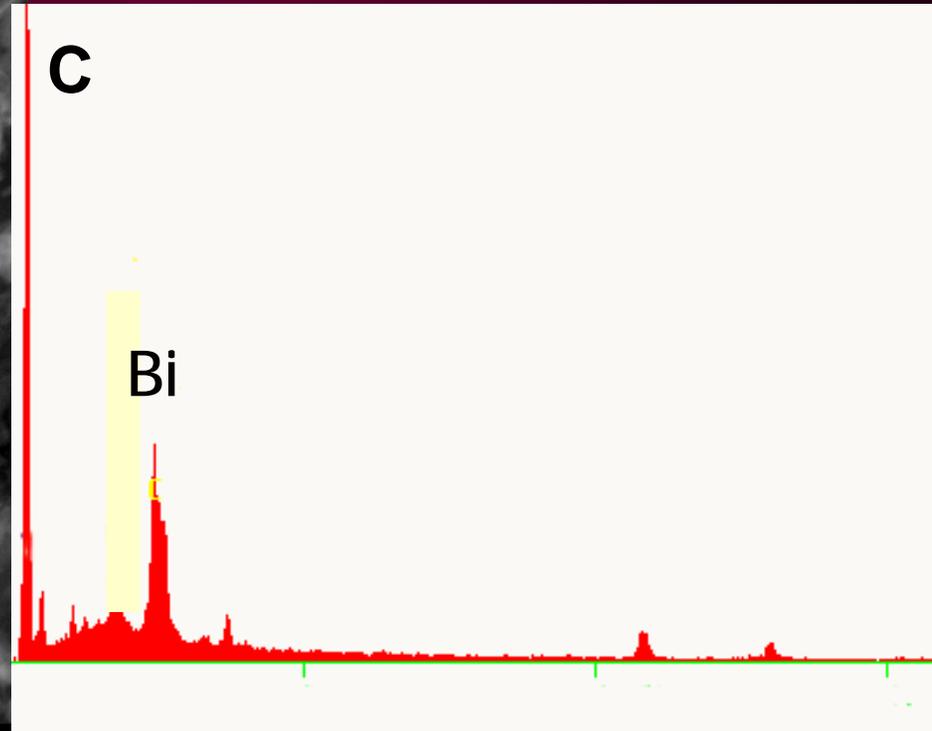
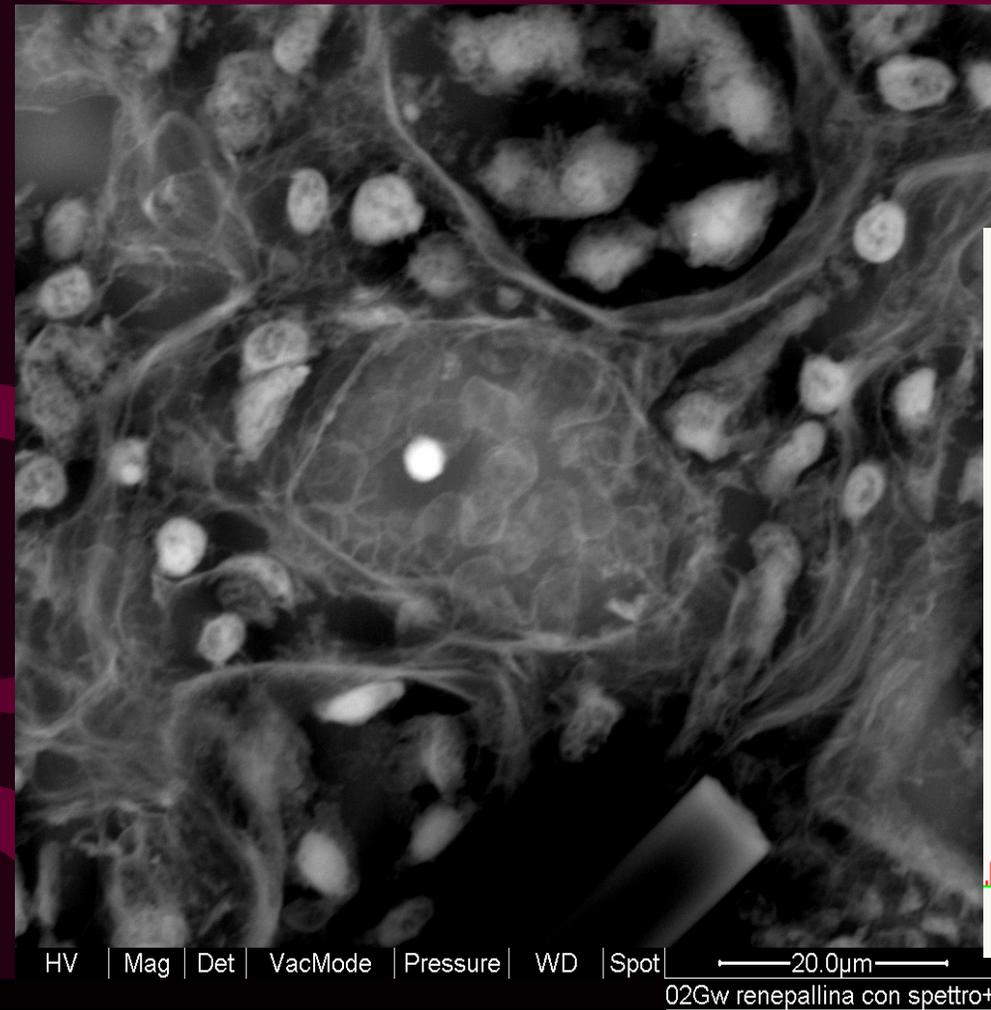
Cluster of nano Hg-Se



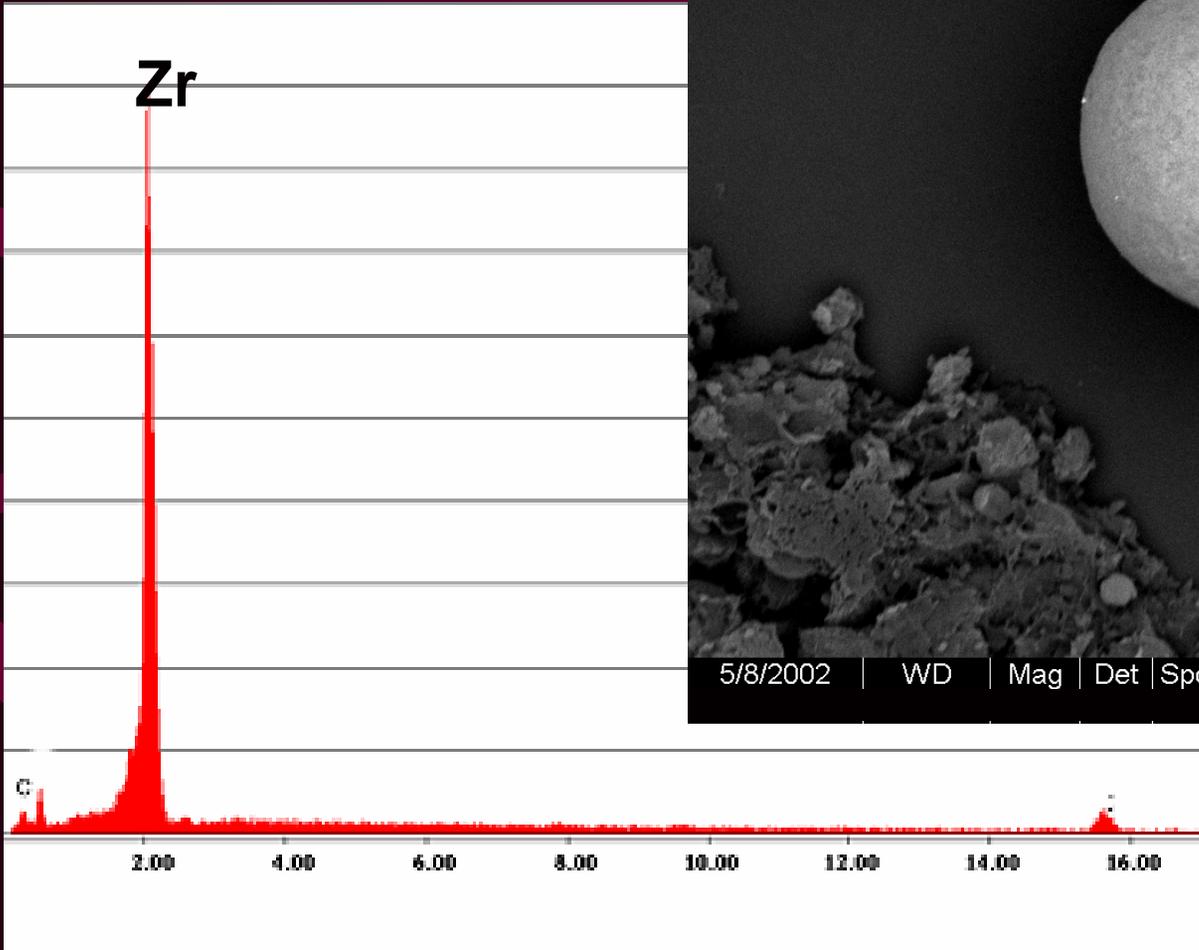
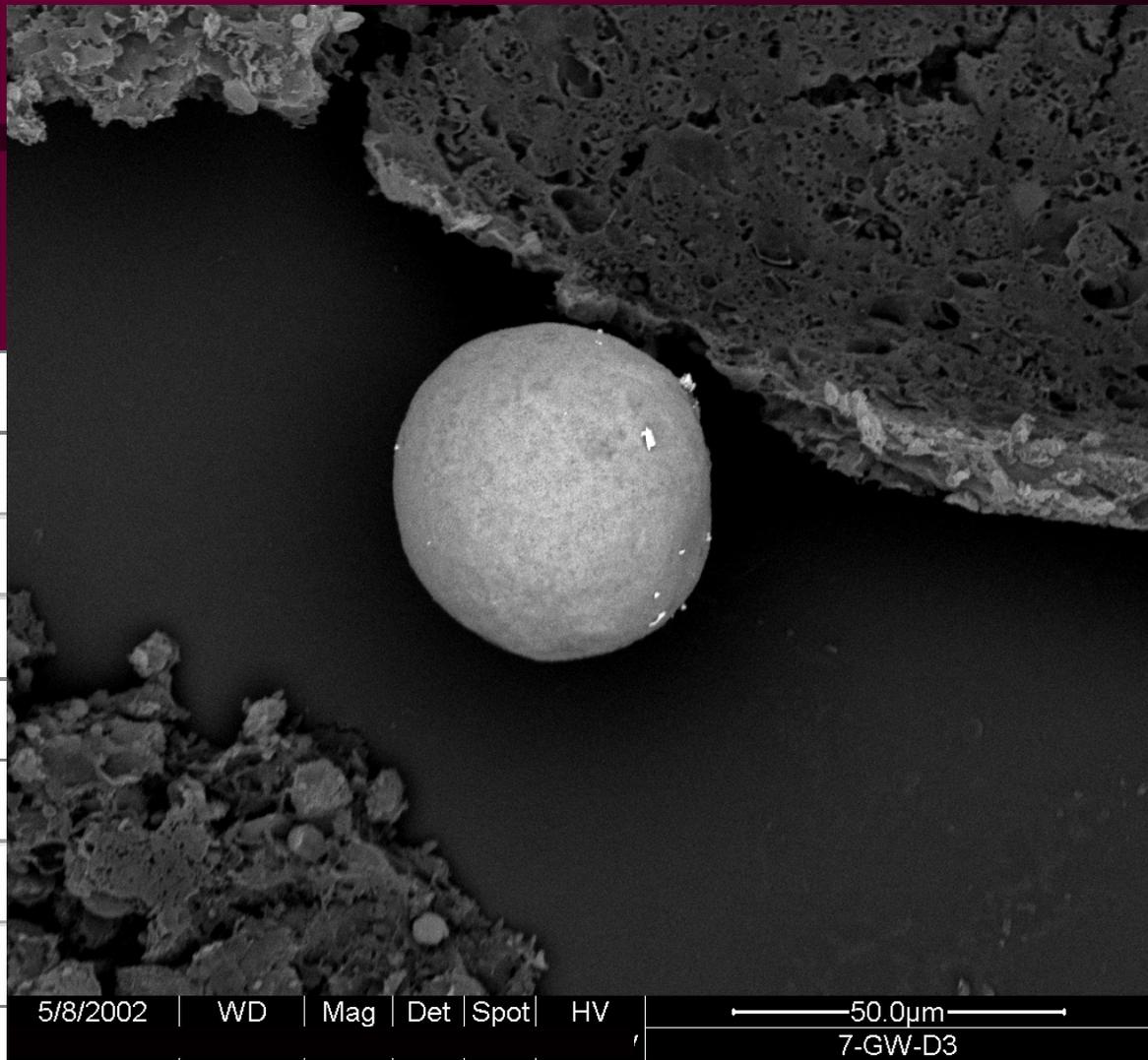
20.0µm

GW 112K/ nano Hg Se

Balkans syndrome: Liver biopsy

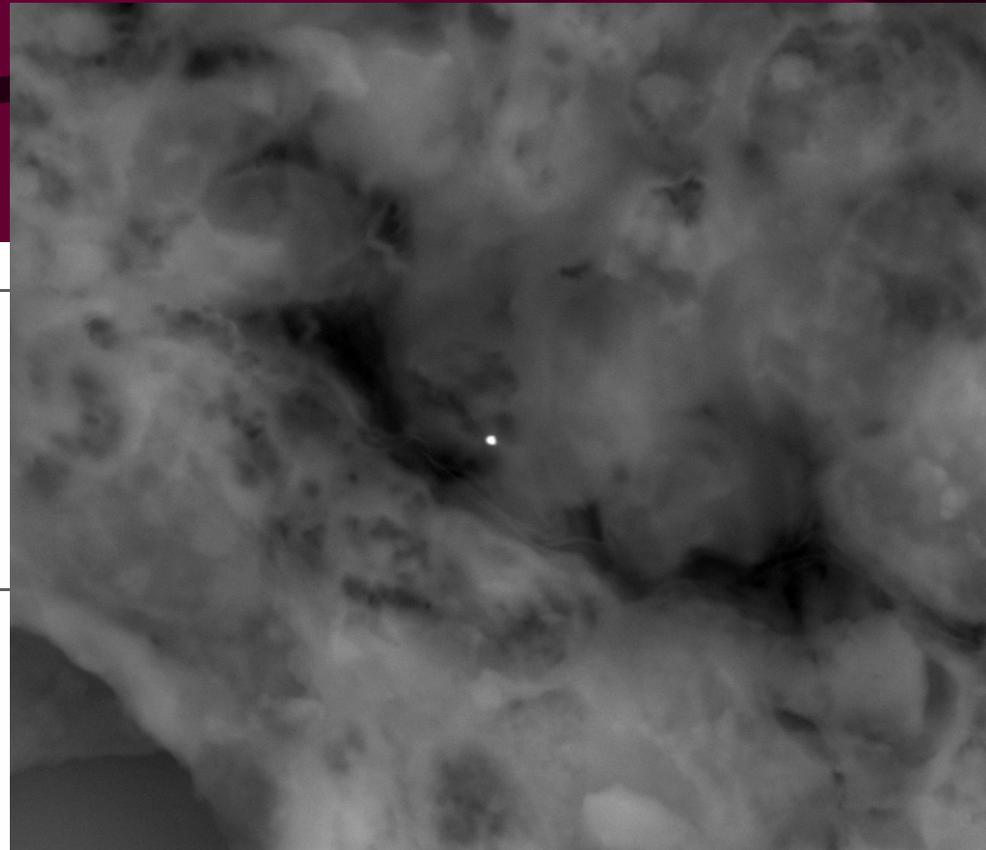


Gastric adenocarcinoma

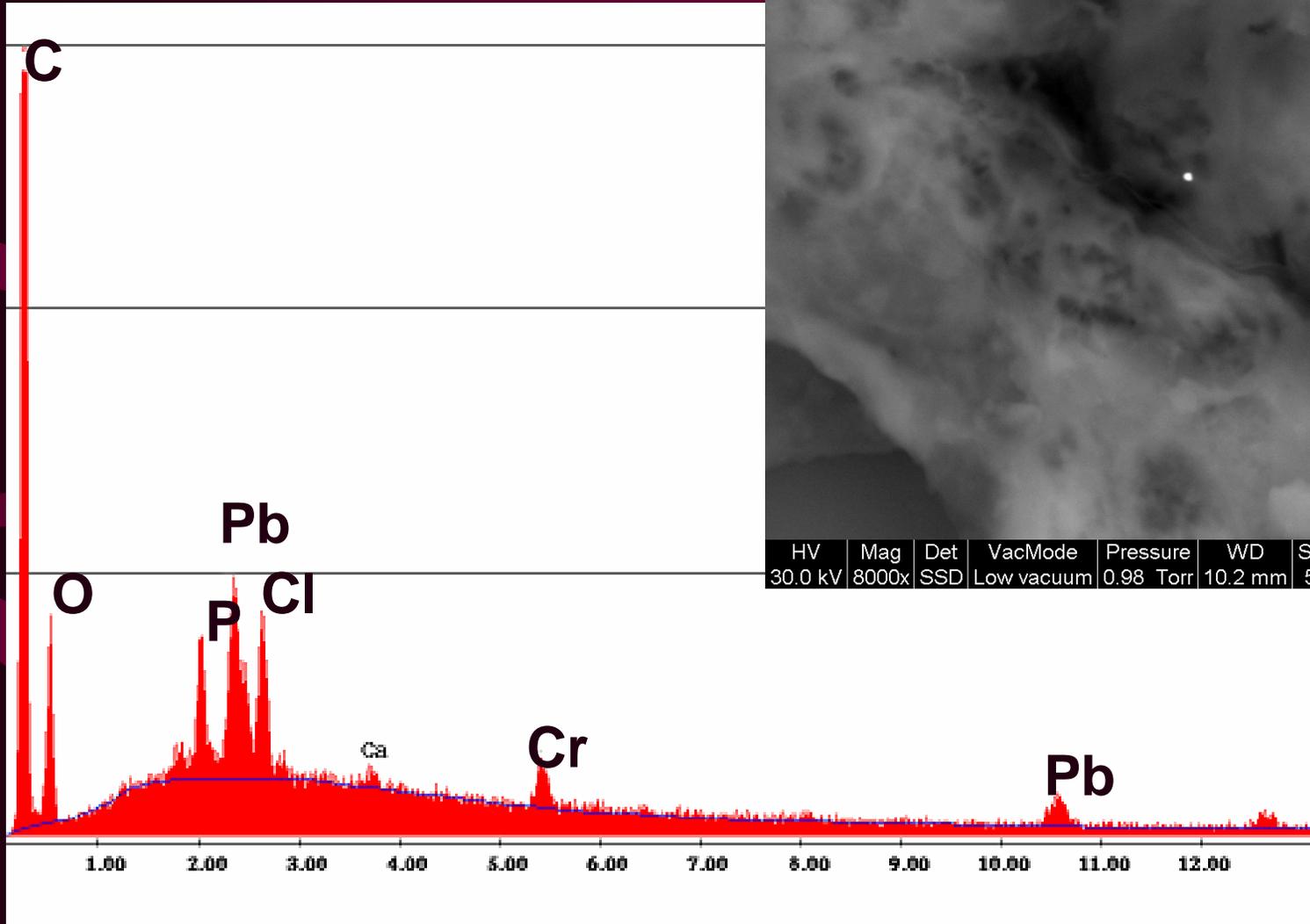


Lymph nodes:

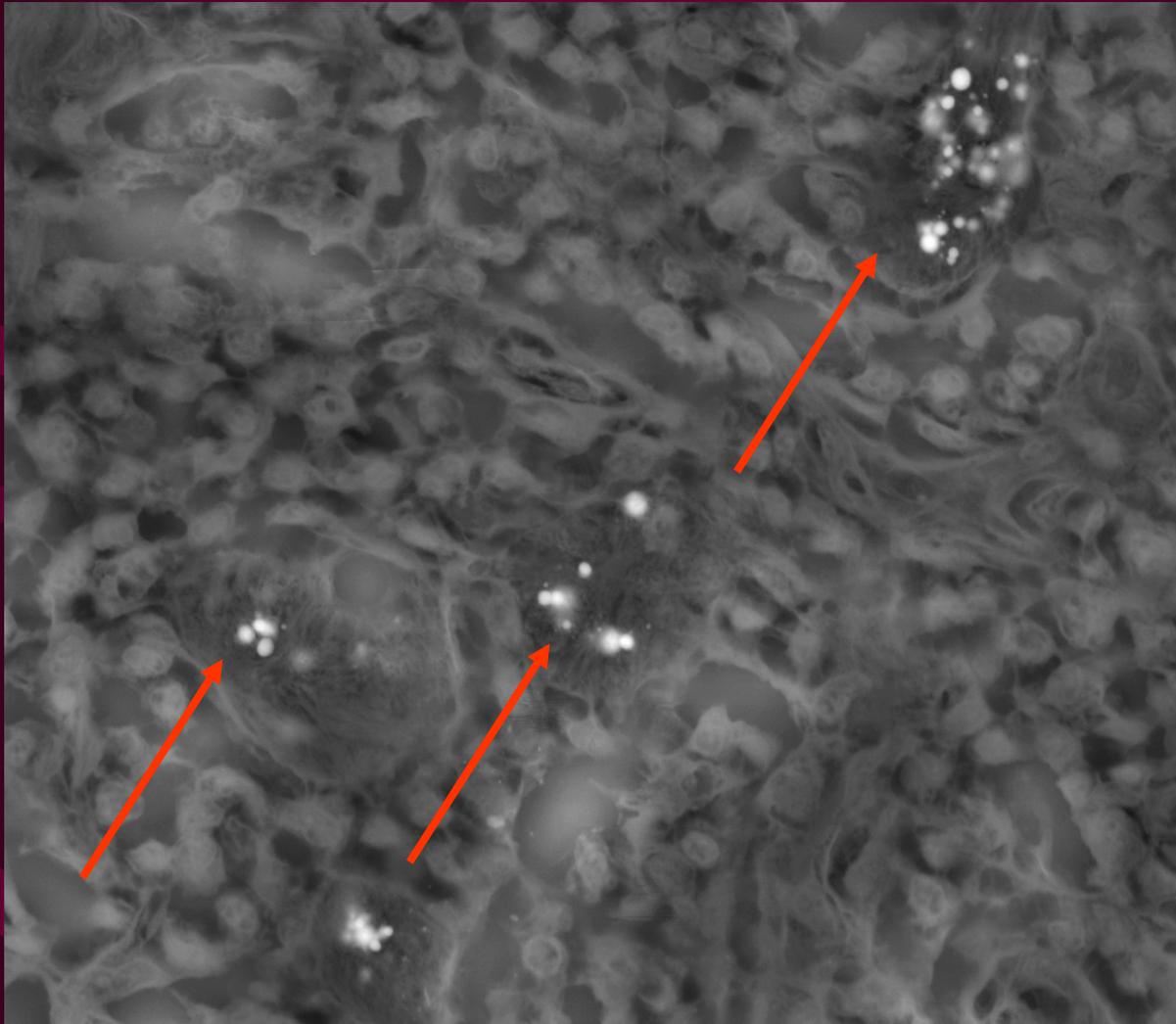
Multiple blood disorder



HV	Mag	Det	VacMode	Pressure	WD	Spot	← 10.0µm →
30.0 kV	8000x	SSD	Low vacuum	0.98 Torr	10.2 mm	5.0	68 GW nano di Pb



Red-Steinberg cells in a lymph node affected by lymphoma containing iron debris

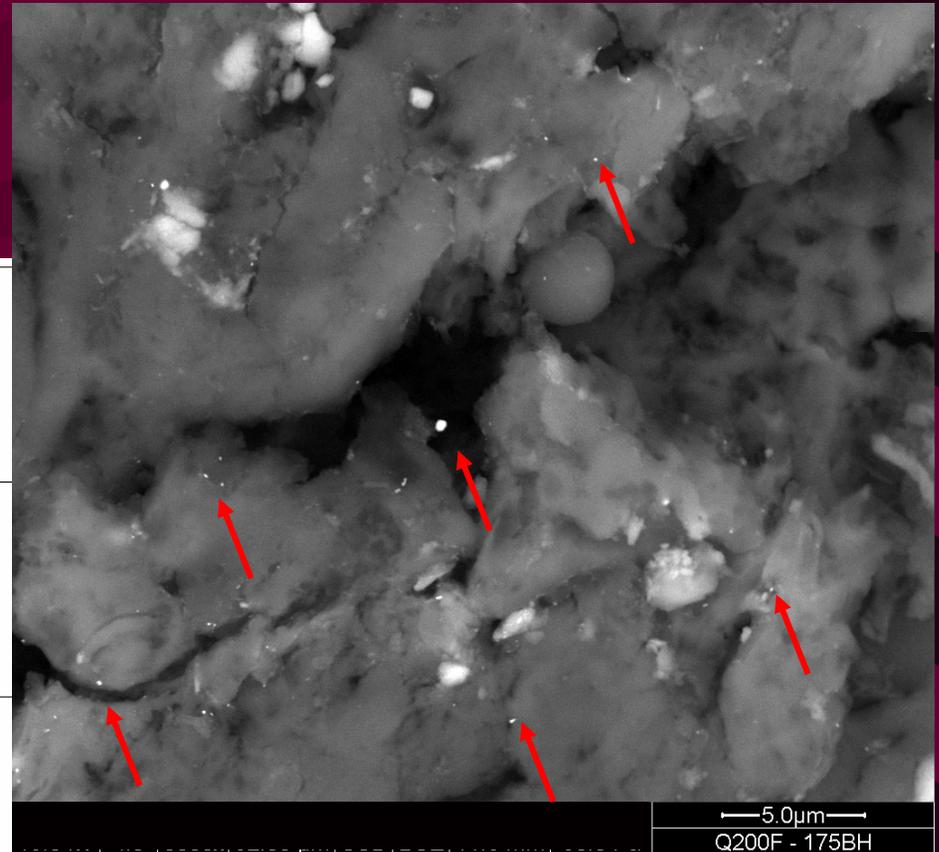
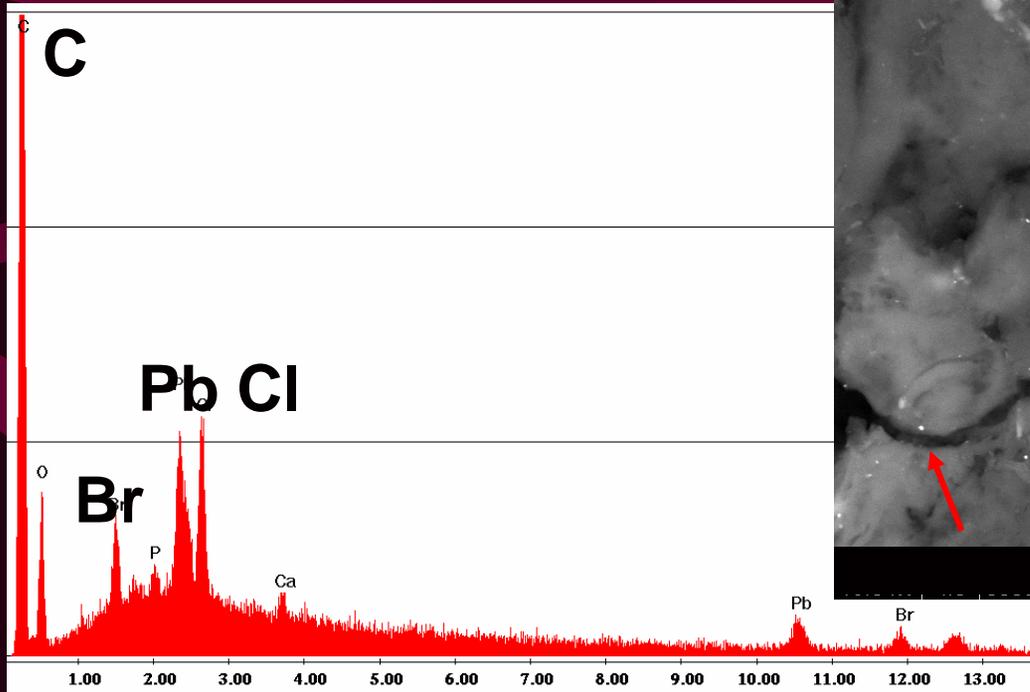


50.0µm

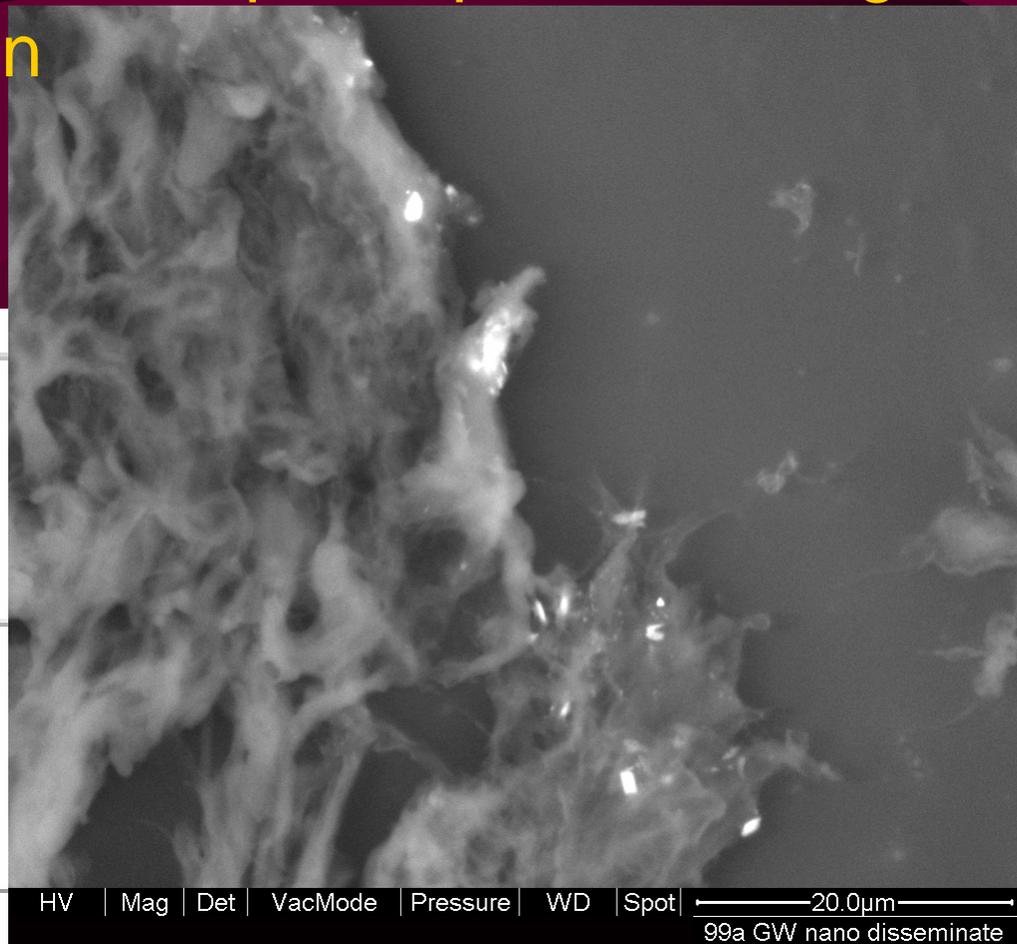
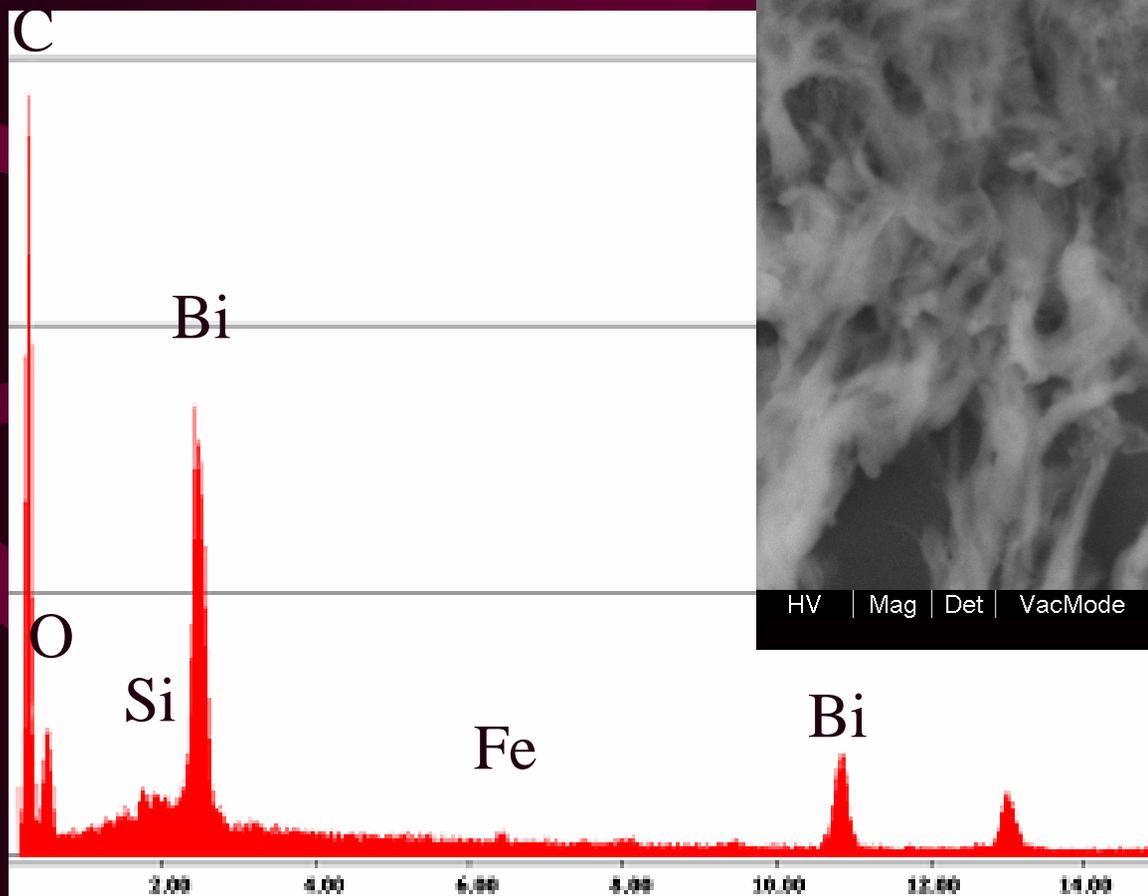
36_cluster

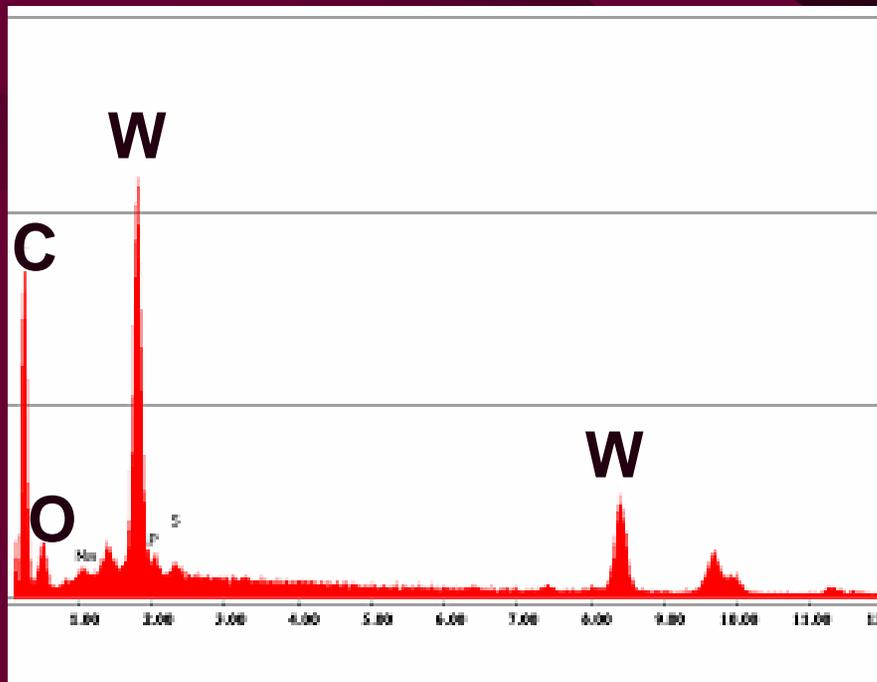
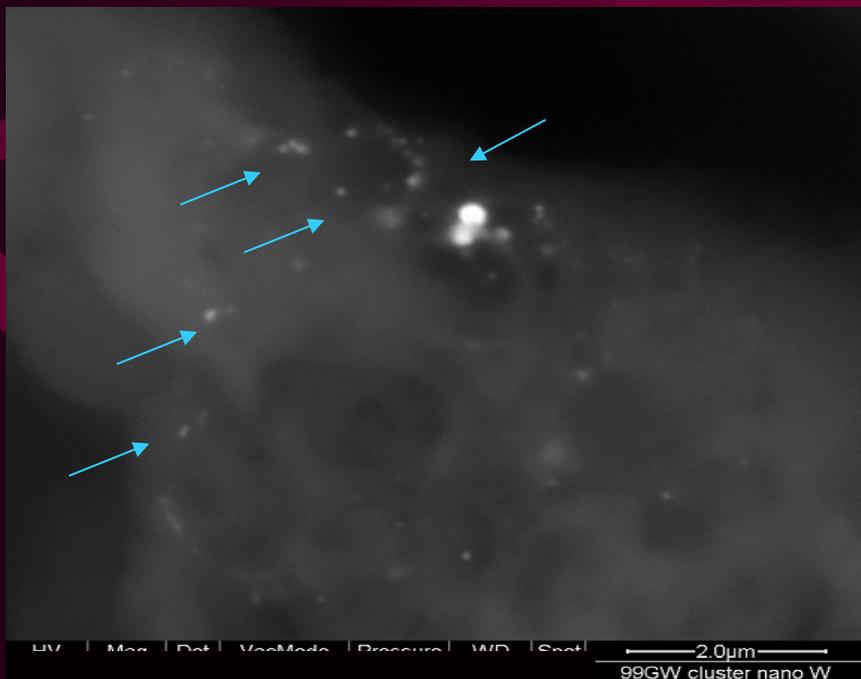
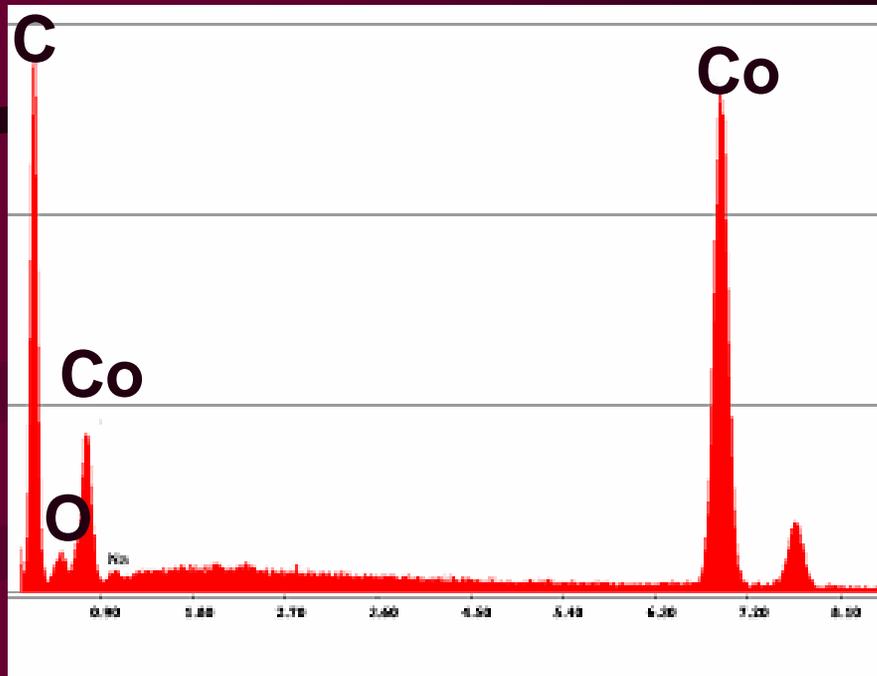
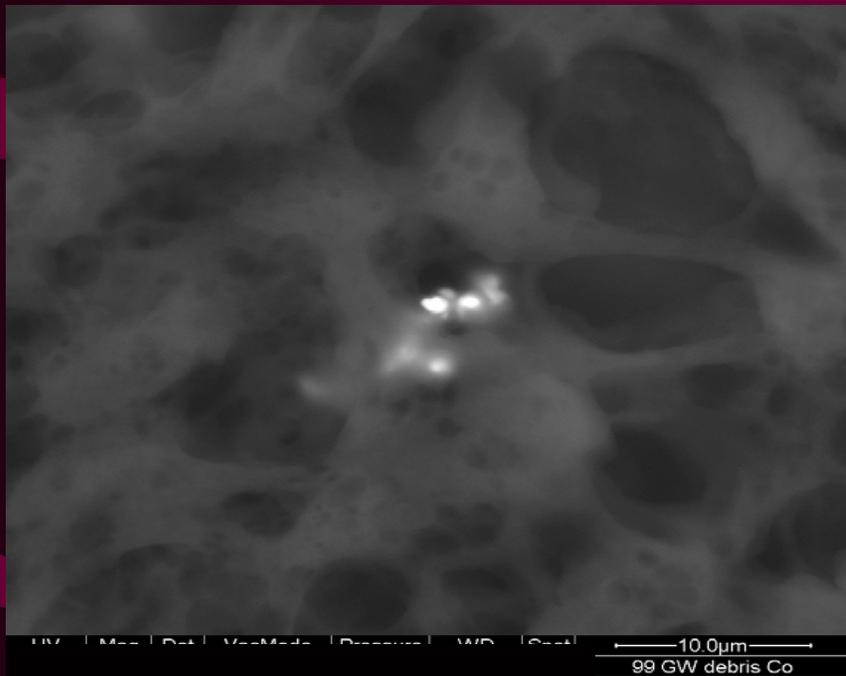
Lymph node of a Sarajevo patient affected by Hodgkin's disease

ESEM-FEG Analysis

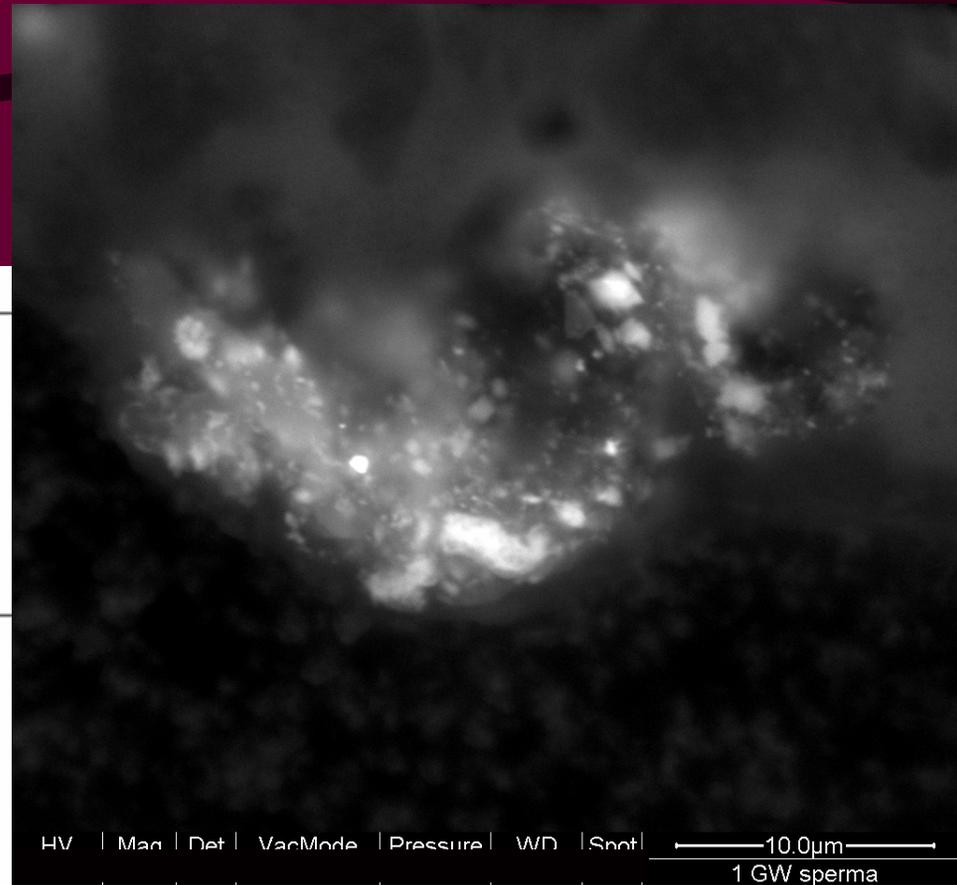
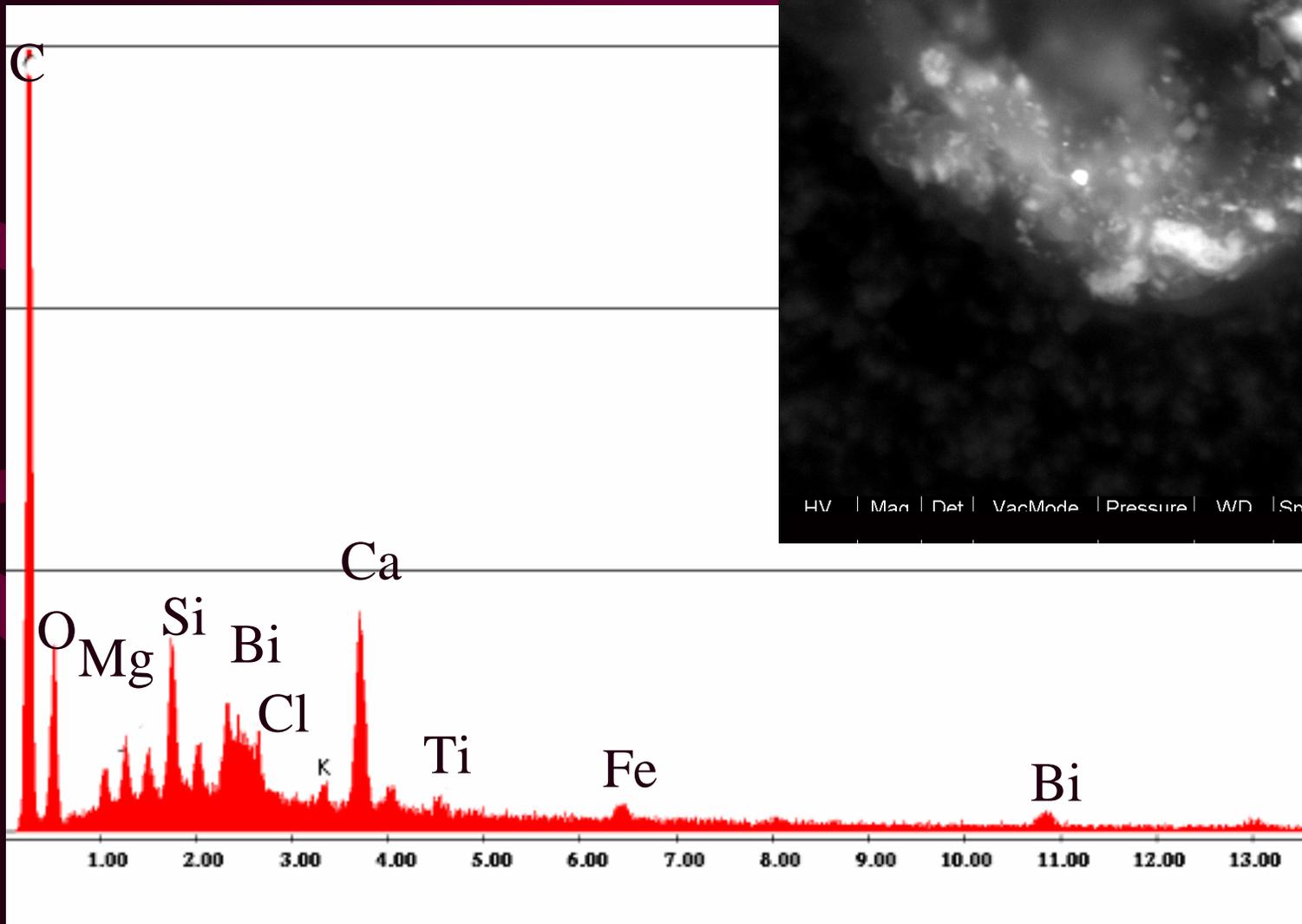


Bladder cancer in a minesweeper exposed to long-lasting weapon pollution



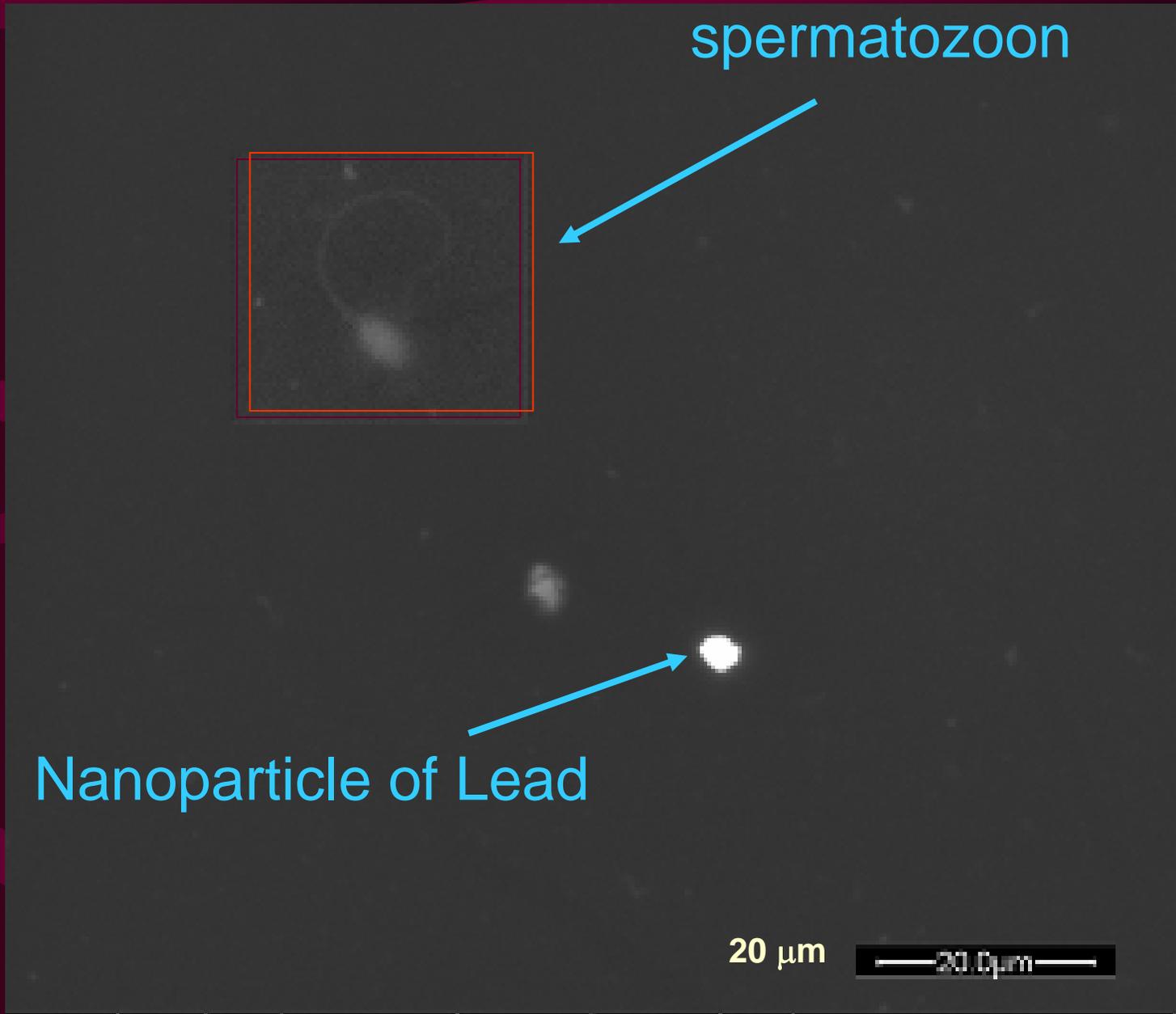


Non-Hodgkin's disease

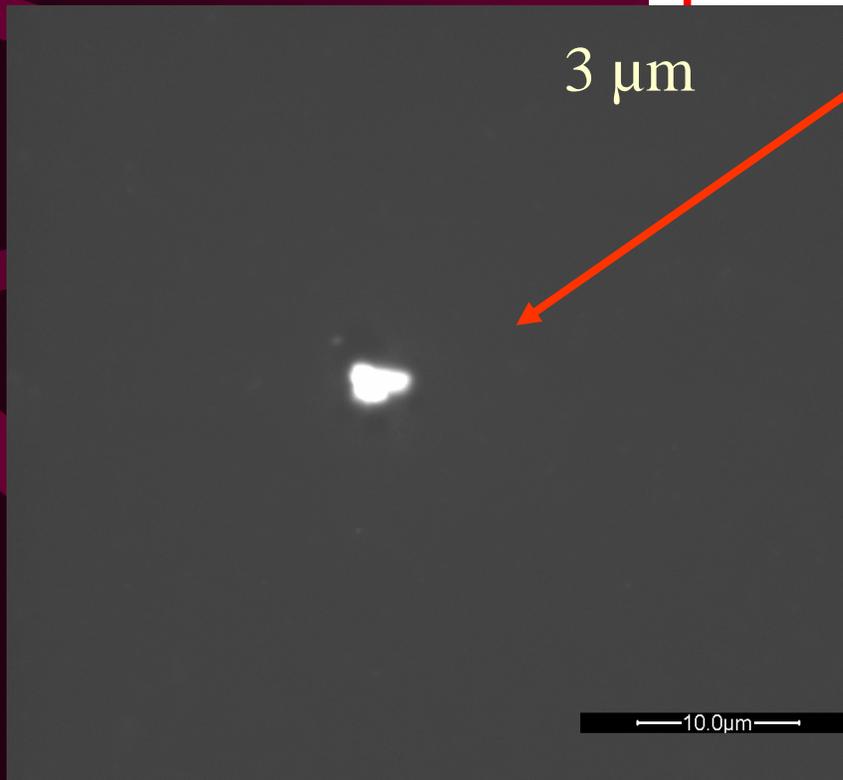
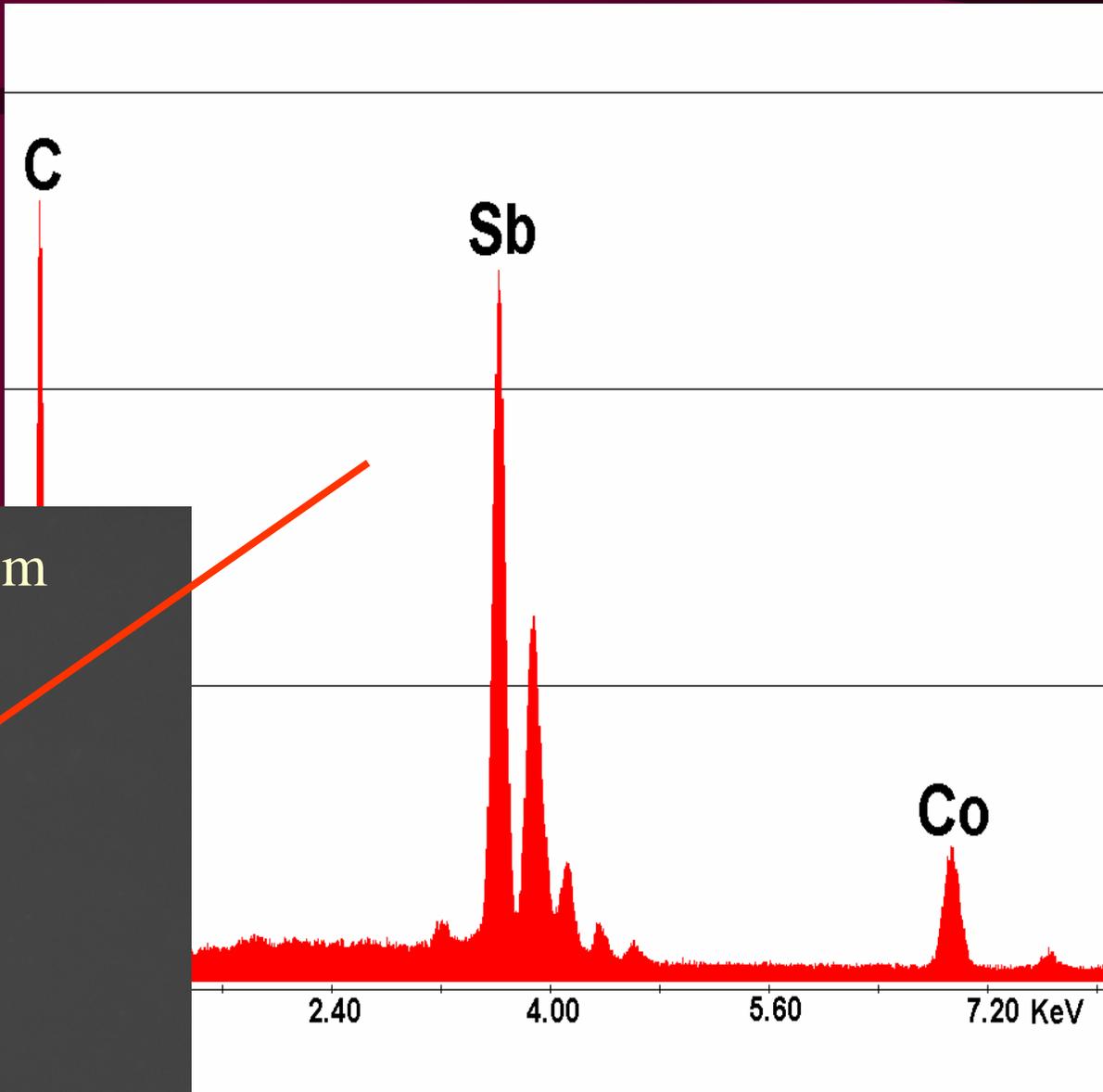


Sperm

Living spermatozoon in sperm in an Italian soldier affected by Hodgkin's lymphoma

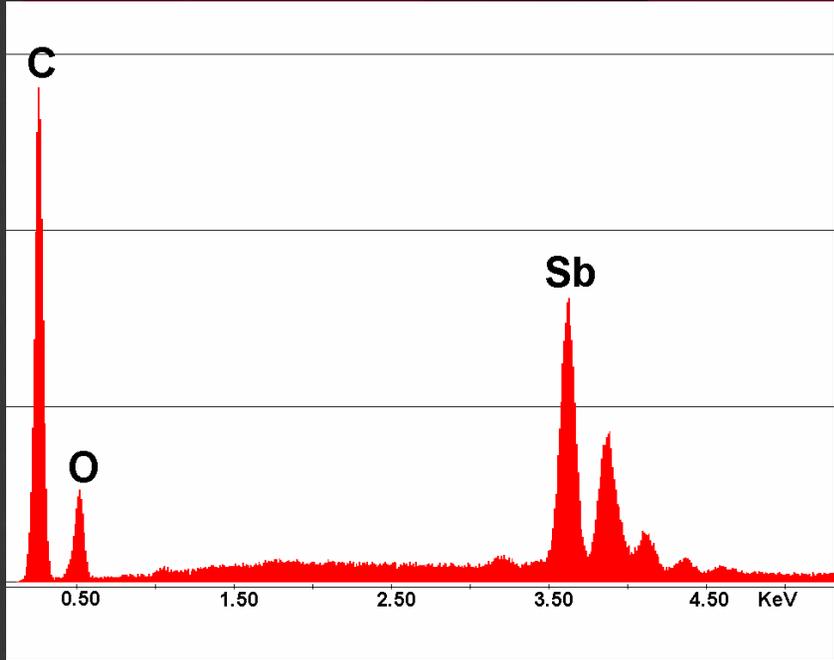


Italian soldier's
sperm affected by
Hodgkin's
disease

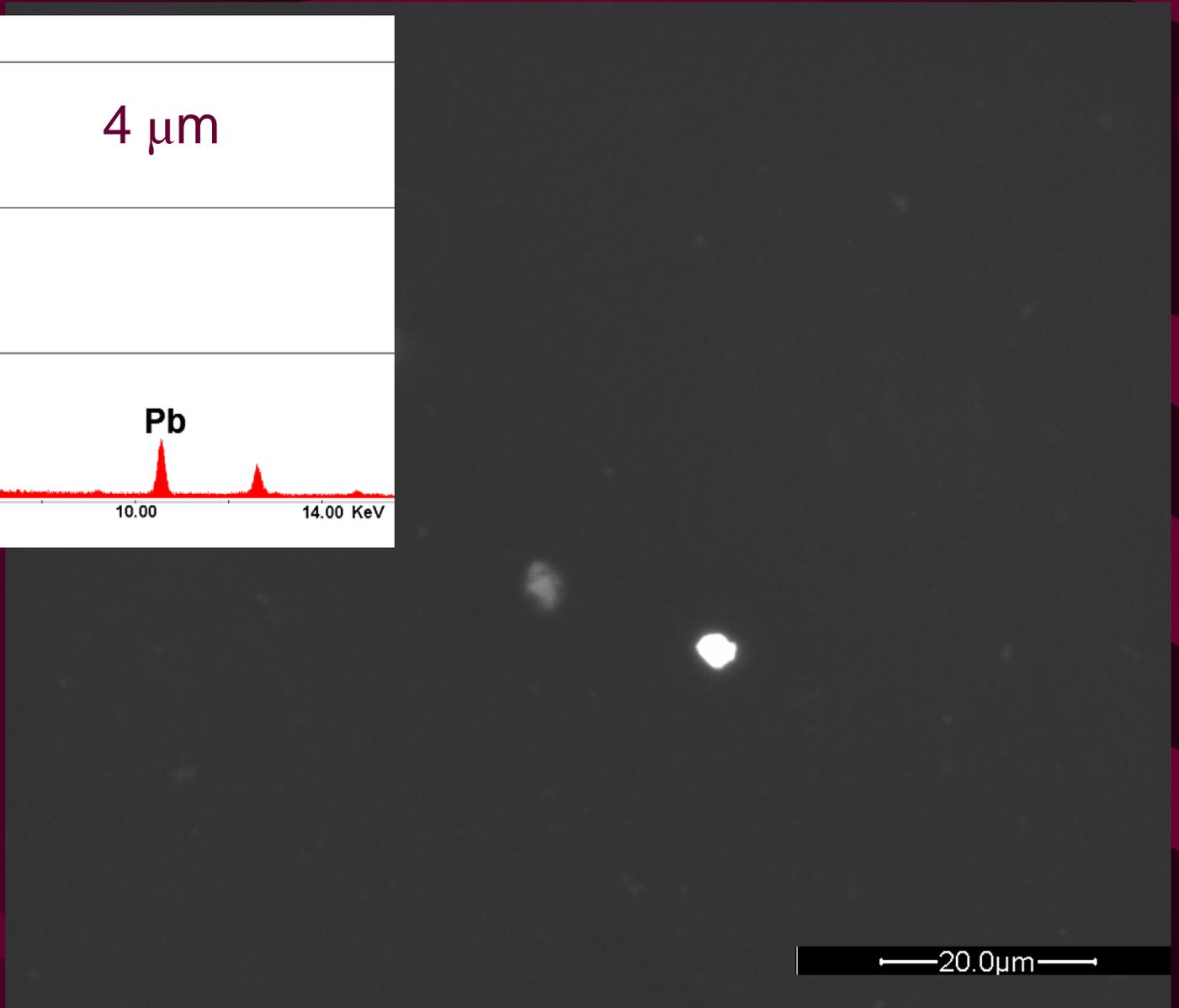
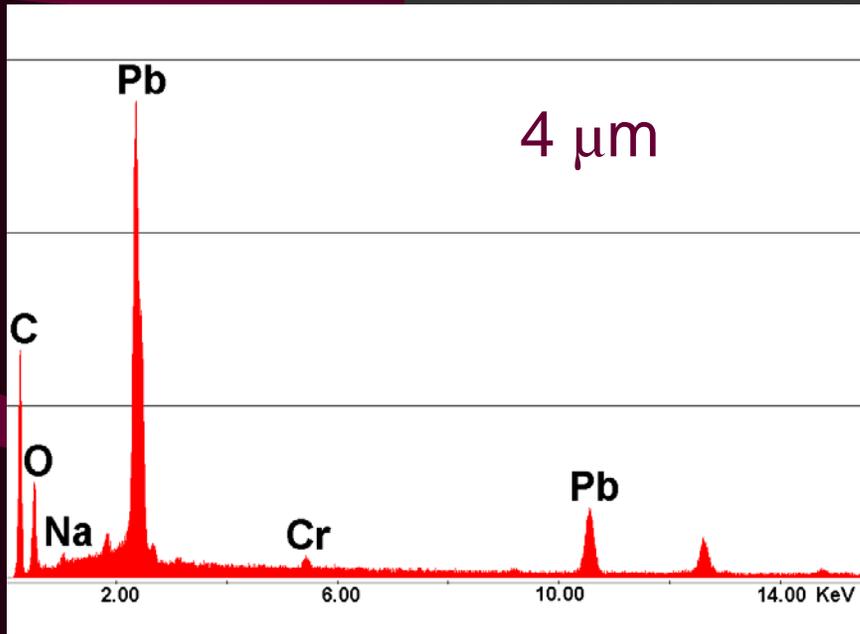


Sperm

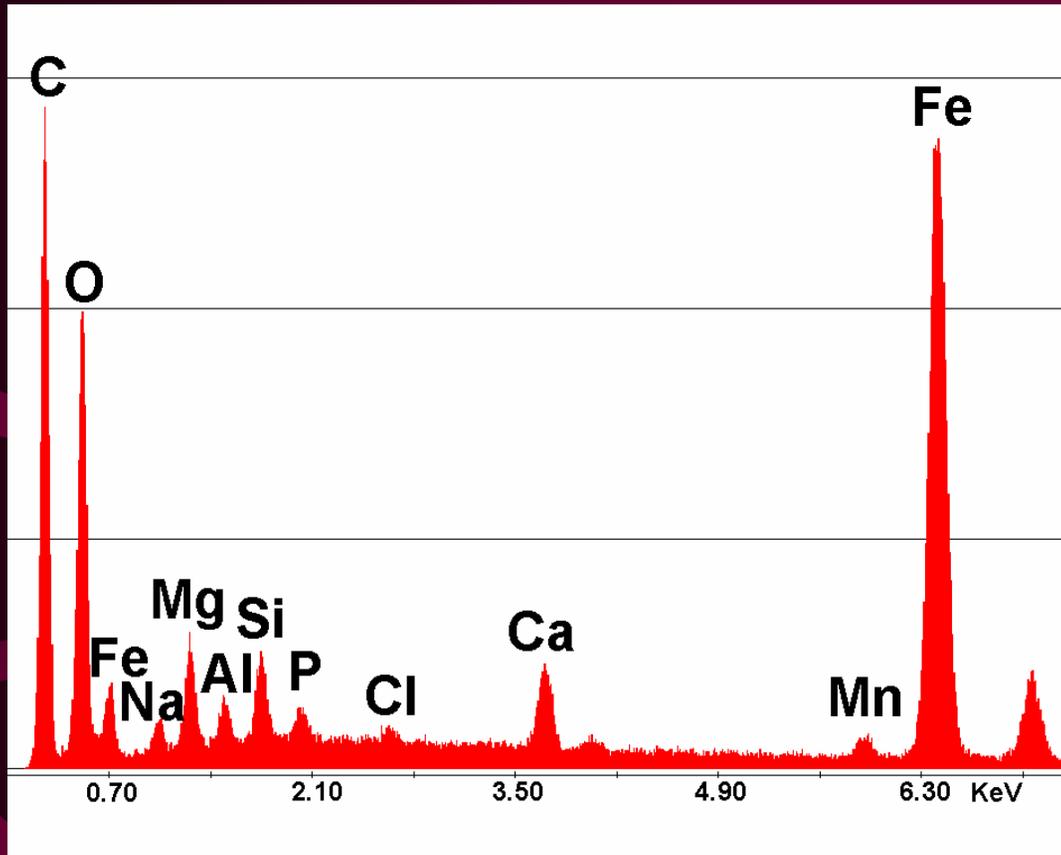
1,5 μm



Sperm



Sperm



2,5 μm



10.0 μm



NANOPATHOLOGIES

- The nanoparticles created in laboratory can be easily confined.
- Nanoparticles are already released in the environment by high temperature combustion processes (incineration or cement plant, foundries, war environmental pollution, etc.) and, when not confined, can trigger pathologies.



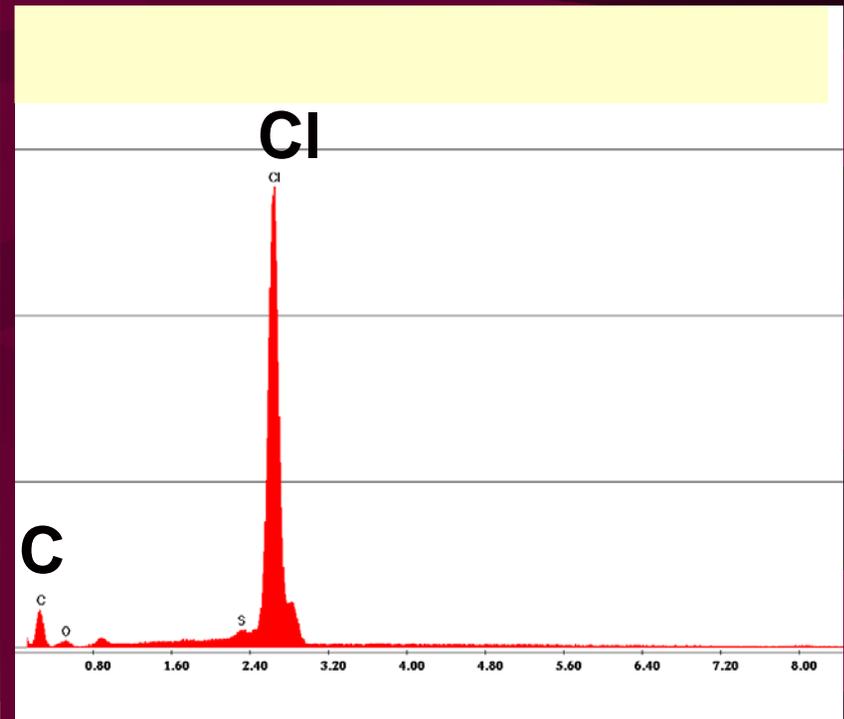
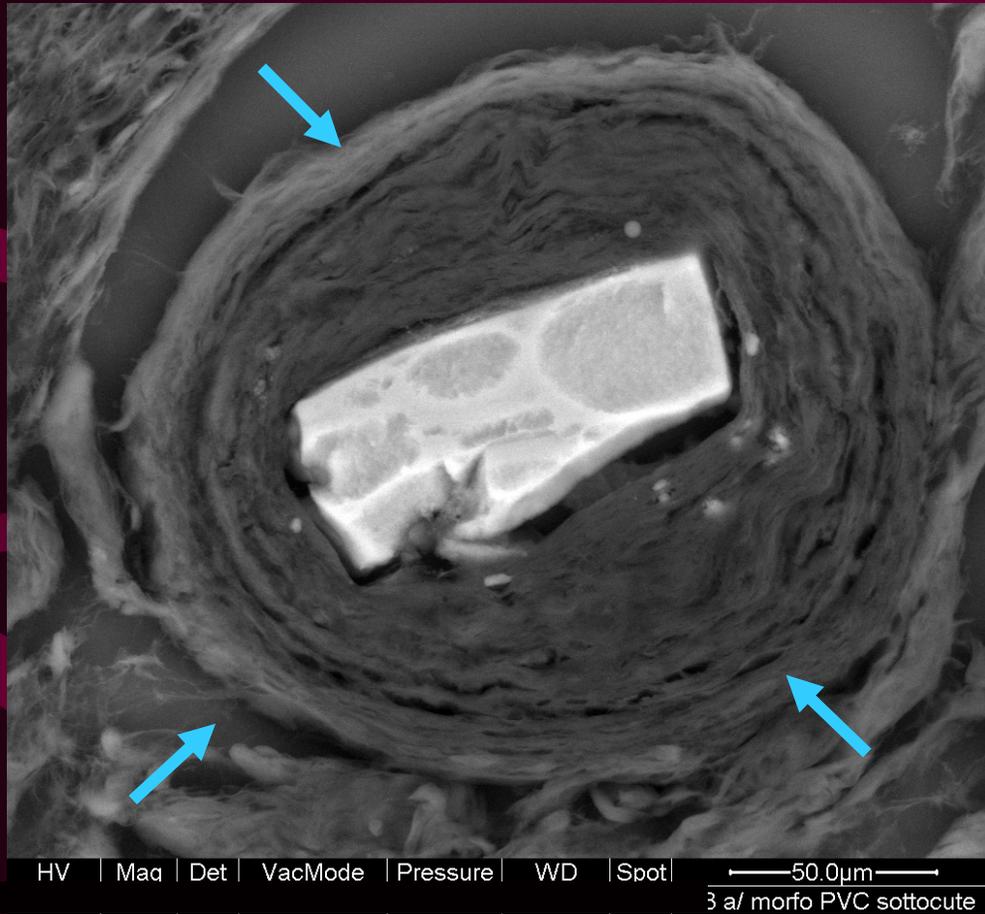
IMPACT ON HUMAN HEALTH



- Can nanoparticles have a pathological meaning for the human health ?
 - ***Evidence says: YES***
- Are the normal cell defence reactions still valid?
 - ***Evidence says: NO***
- What is the possible pathomechanism?
 - ???**

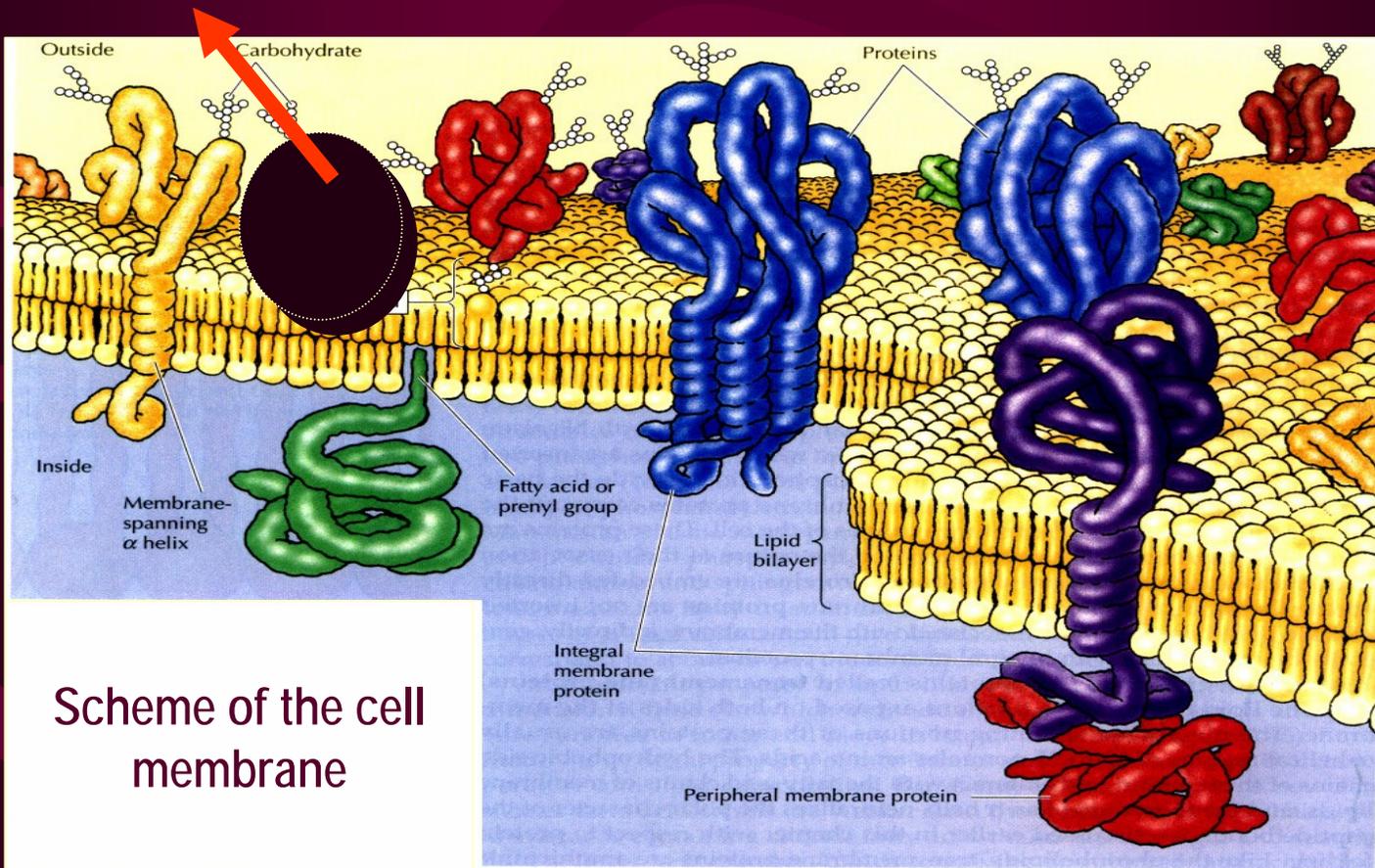
SIZE DOES REALLY MATTER

Example of tissue reaction to bulk materials (PVC)



What is the cell reaction to a discrete, non continuous stimulus?

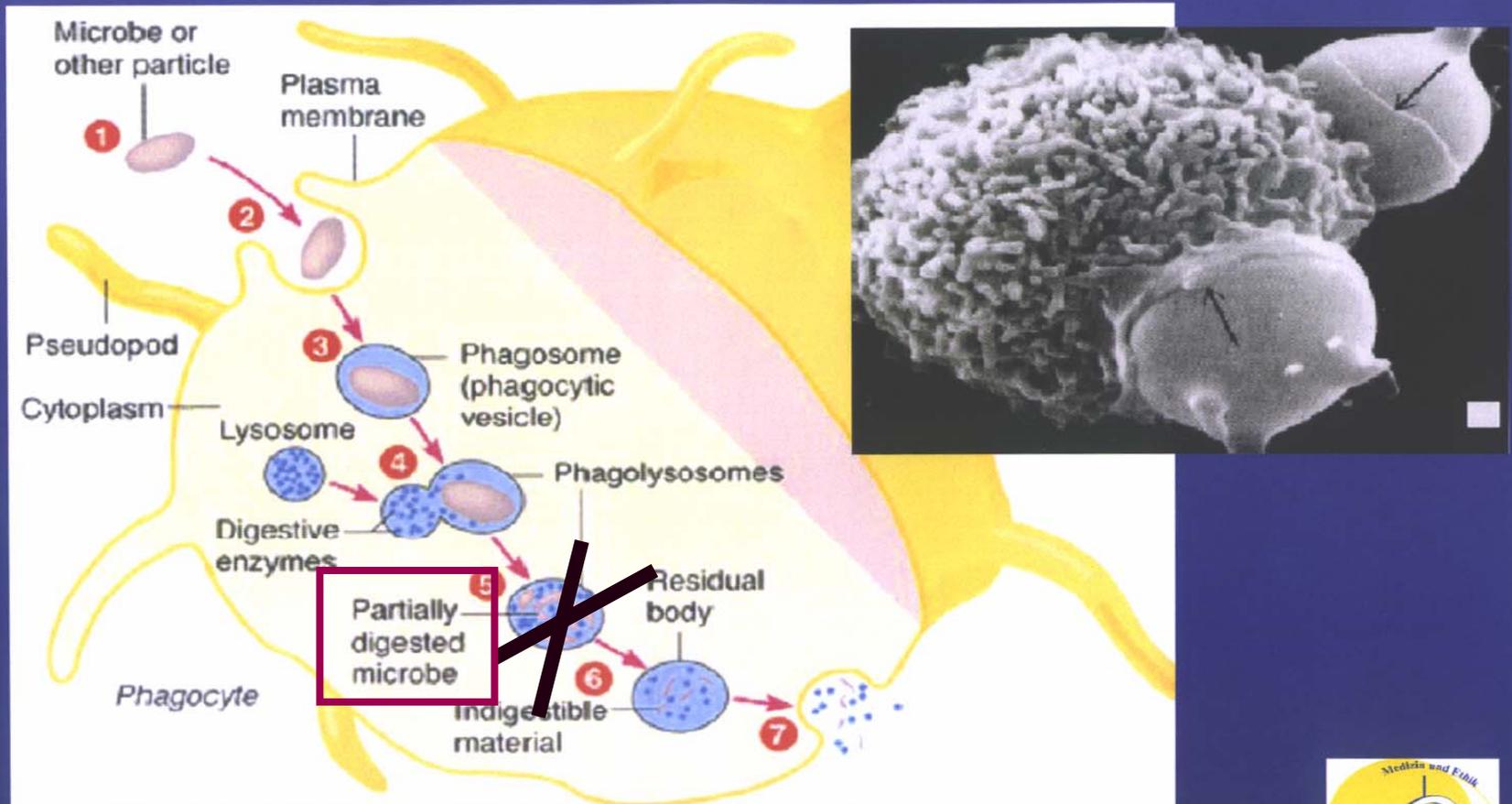
Discrete stimulus



Scheme of the cell membrane

Is the mechanism of the phagocytosis still valid for not biodegradable nanoparticles ? NO

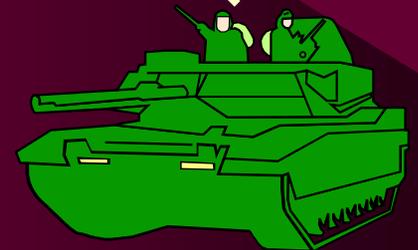
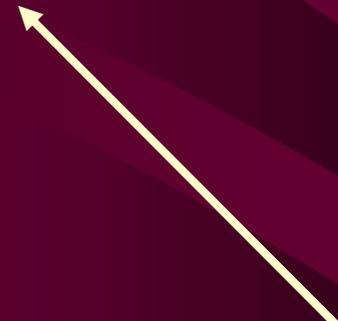
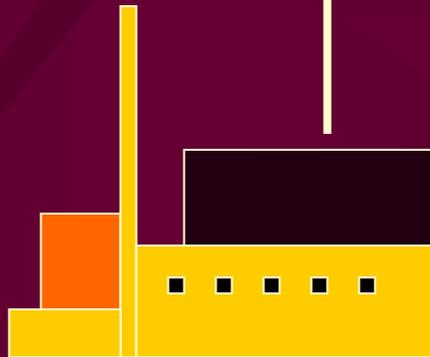
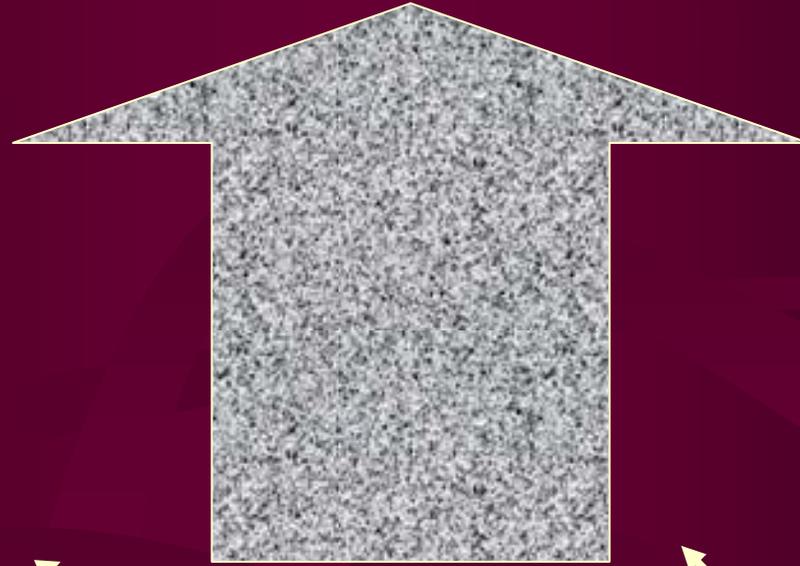
Phagocytosis



Pollution due to:

1. Traffic
2. Incineration, cement plant
3. DU weapon explosions

Can also create nanosized debris





The research was supported by the European
Community (Project n. QLK4-2002-147)