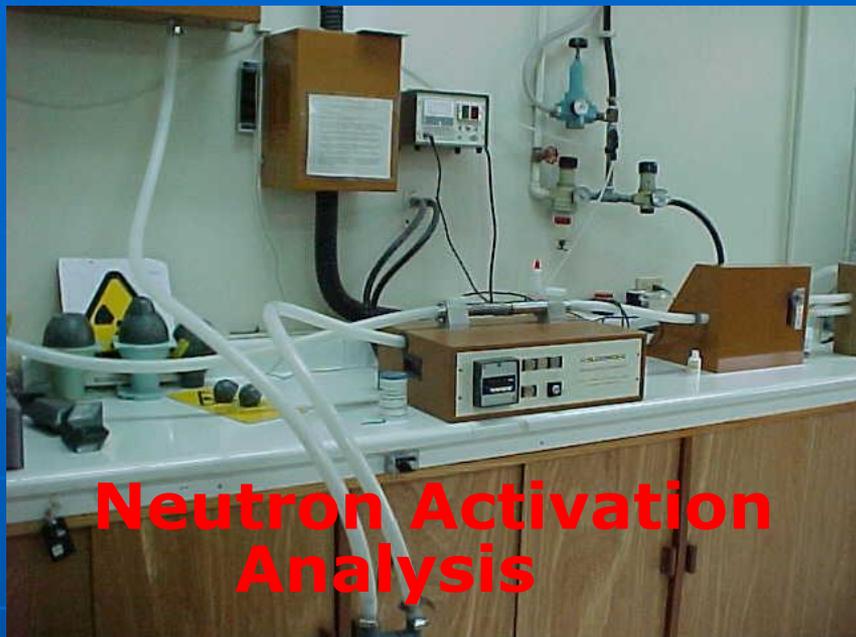


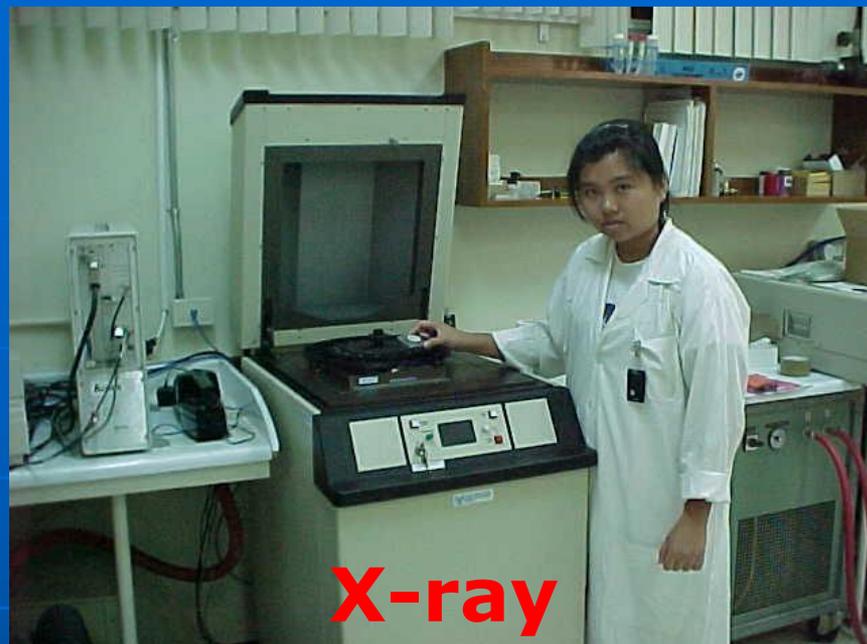
*Mercury and Health
Research in Jamaican using
Nuclear Techniques*

Prof. Mitko Voutchkov

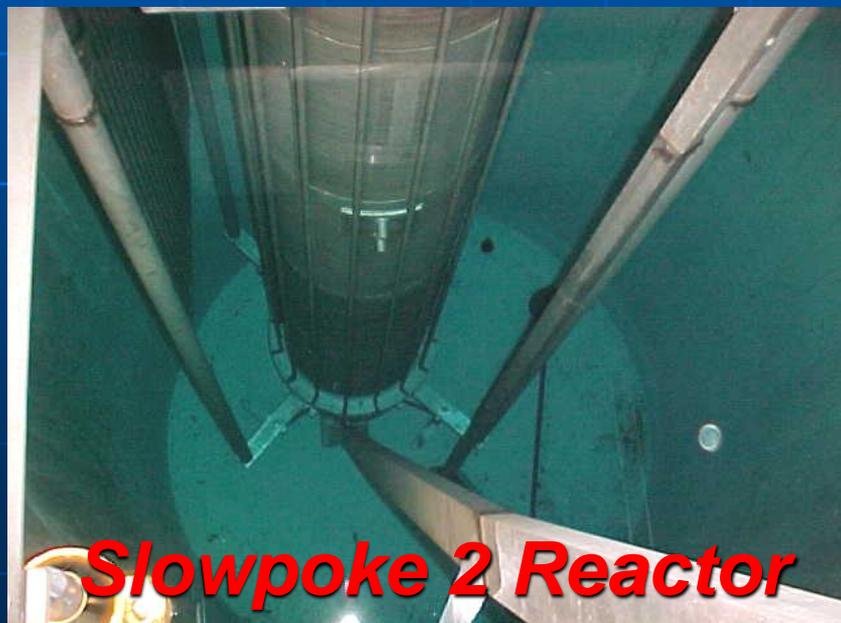
University of the West Indies, Mona
Jamaica



Neutron Activation Analysis



**X-ray
Fluorescence**



Slowpoke 2 Reactor



Thermo Scientific Niton XL3t GOLDD+ XRF Analyzer



CCD camera and small-spot feature isolates and stores small sample area measurements.



EPA Field Demonstration Quality Assurance Project Plan

Field Analysis of Mercury in
Soil and Sediment

Table 1-1. Summary of Vendor Technologies.

| INSTRUMENT PARAMETER | VENDOR NAME | | | | |
|----------------------------------|--------------------------|--|--|-------------------------|-----------------------------|
| | Metorex, Inc. | Milestone Inc. | NITON LLC | Ohio Lumex Co. | MTI, Inc. |
| Principle of Operation | XRF | TD/AAS | EDXRF | AAS | ASV |
| Analytical Range ¹ | 10 to 1,000 mg/kg | 50 µg/kg-5 mg/kg (8 µg/kg with larger sample aliquot) | 20 to 1,000 mg/kg | 5 µg/kg to 100 mg/kg | 100 µg/kg to 1,000 mg/kg |
| MDL ² | 10 mg/kg | 50 µg/kg | 20 mg/kg | 5 µg/kg | 100 µg/kg |
| Potential Interferences | High Pb, As, Se, & Zn | VOCs, concentrated inorganic acids, & heavy metals | Pb, As, and Zn > 500 mg/kg | None Identified | High Ag |
| Accuracy ¹ | 15-20% | +/- 10% | At 100 mg/kg +/- 15% | +/- 10% | +/- 10% |
| Precision ¹ | 5-20% | +/- 5% | 10% RSD @ 60 ppm to 20% for environmental samples | +/- 10% | +/- 15% |
| Required Sample Size | 8 g | 0.01 to 5 g | 5 to 10 g | 0.01 to 0.2 g | 2 to 5 g |
| Expected Throughput ³ | 10/hr | 12/hr | 25/hr - direct analysis; 10/hr with preparation | 10/hr | 10/hr |

¹ This information is based solely upon vendor claims. These claims will be evaluated during the Demonstration.

² MDL for soil and sediment.

³ Sample analyses based upon multiple hours of operation

µg/kg - micrograms per kilogram

mg/kg - milligrams per kilogram

AAS - Atomic Absorption Spectrometry

As, Cu, Hg, Pb, Se, and Zn - Arsenic, Copper, Mercury, Lead, Selenium and Zinc, respectively

ASV - Anodic Stripping Voltammetry

EDXRF - Energy Dispersive X-Ray Fluorescence



In Situ Characterization of soils



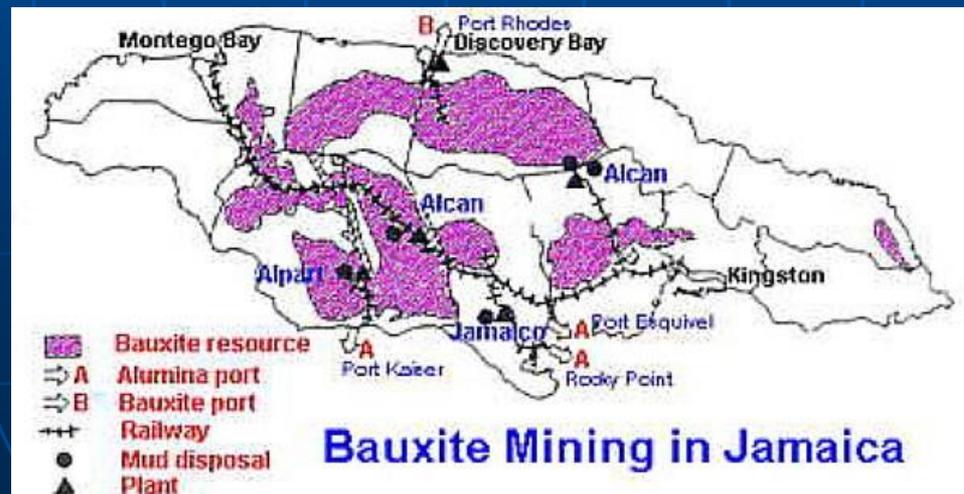
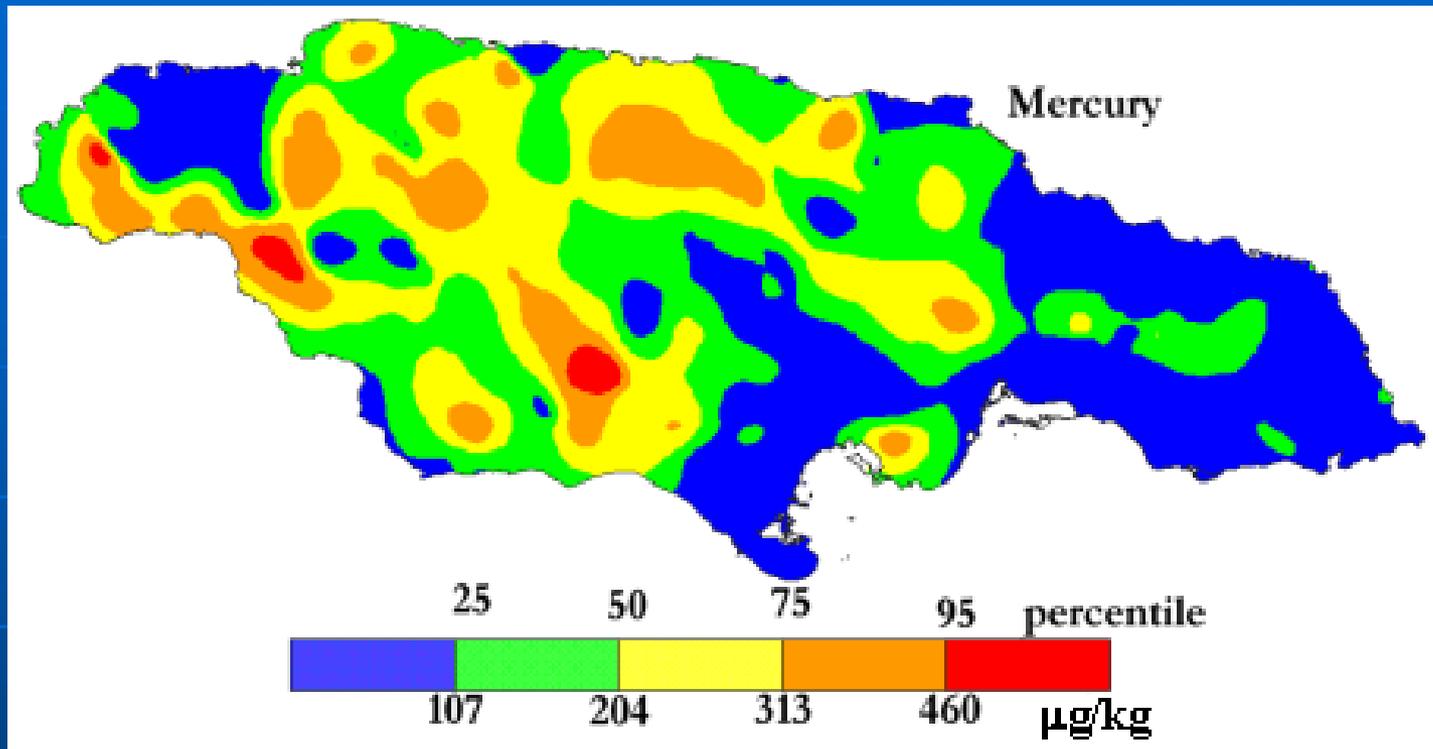


In-situ characterisation of red mud using a handheld XRF analyzer

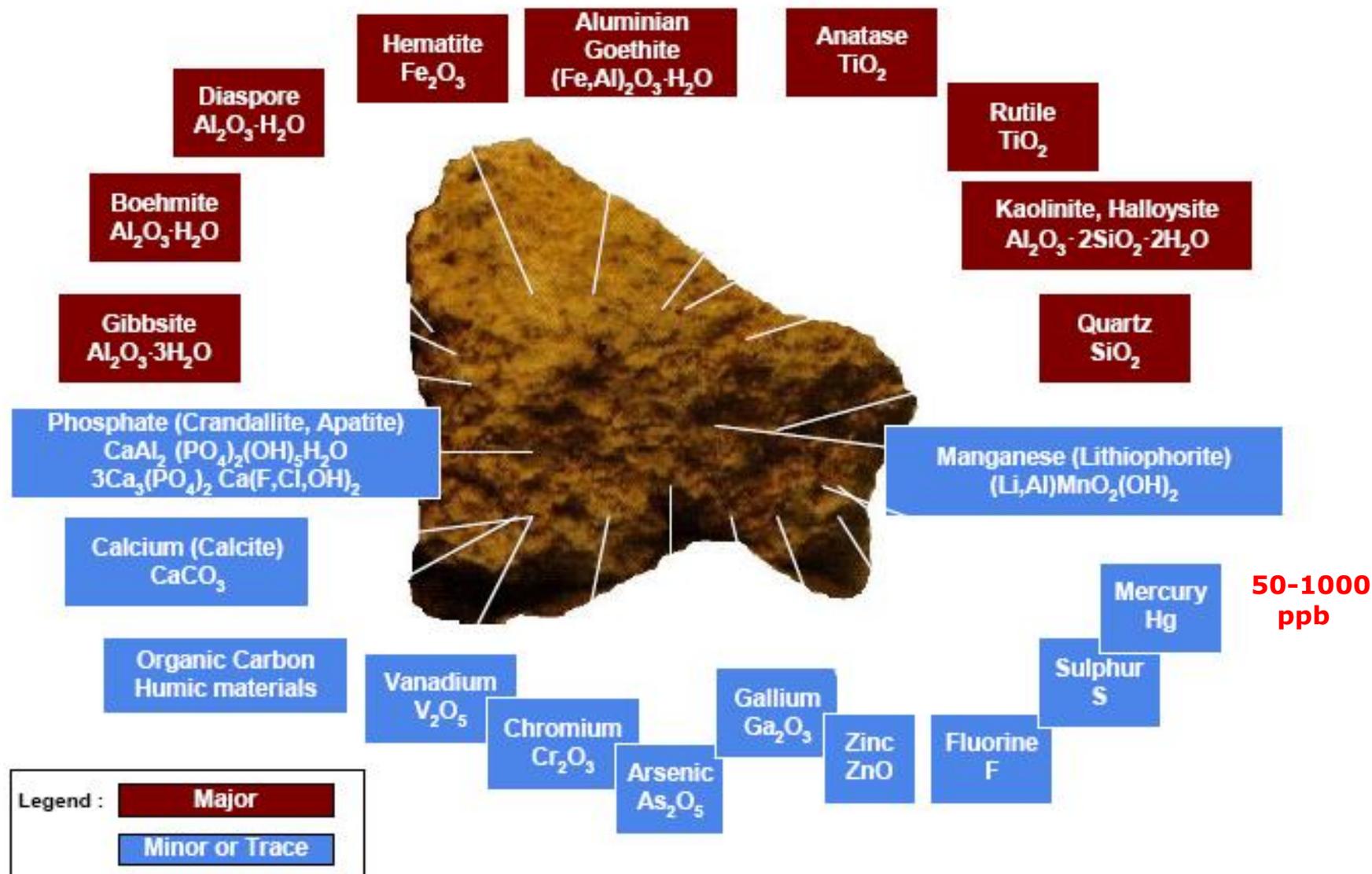




Mercury levels in Jamaican soils



Bauxite: Typical Composition

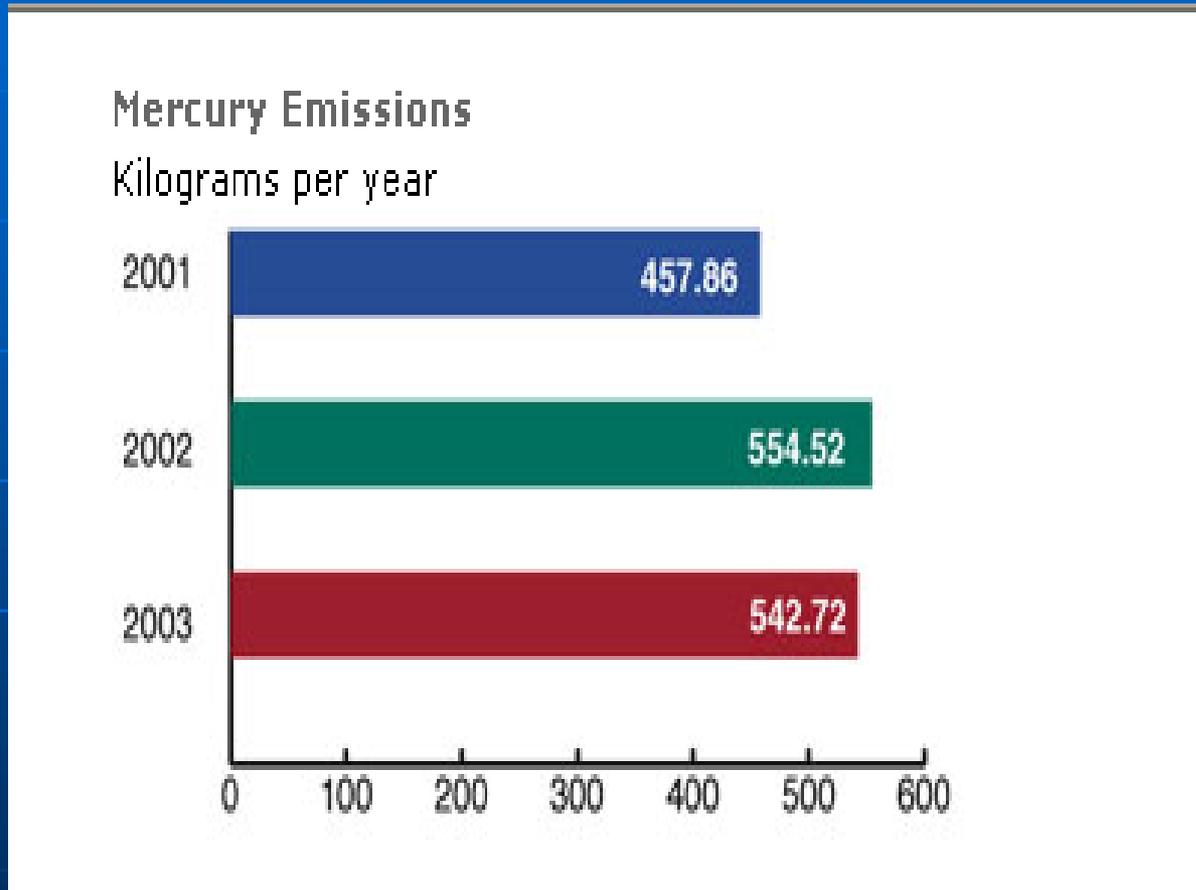


Bauxite: Typical Composition

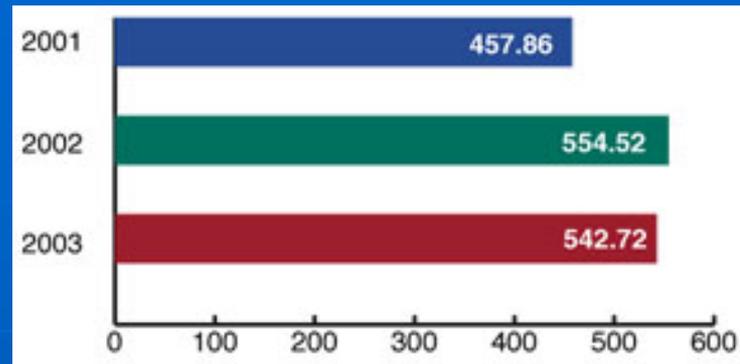


| Components | Wt. % (as metallic oxide if not indicated otherwise) |
|-------------------------|---|
| Al_2O_3 | 30-60 |
| Fe_2O_3 | 1-30 |
| SiO_2 | <0.5-10 |
| TiO_2 | <0.5-10 |
| Organic Carbon (as C) | 0.02-0.40 |
| P_2O_5 | 0.02-1.0 |
| CaO | 0.1-2 |
| V_2O_5 | 0.01-0.10 |
| ZnO | 0.002-0.10 |
| Ga_2O_3 | 0.004-0.013 |
| Cr_2O_3 | 0.003-0.30 |
| S | 0.02-0.10 |
| F | 0.01-0.10 |
| Hg (ppb) | 50-1000 |

Hg emissions, 2001-2003 (Alcoa)



JAMALCO – Alcoa Minerals of Jamaica, Sustainability Report of 2003 indicates a target to reduce Hg emissions by 80% by 2008



- Minute amounts of mercury (0.2 to 0.3 parts per million) occur naturally in bauxite. During refining, approximately **20%** of the mercury that enters our process exits with the bauxite residue, a by-product that is stored in well-engineered and operated residue areas to prevent the release of their contents to the natural environment.

An extremely **small amount of mercury is lost** to the environment on an annual basis. An even smaller amount is found in the alumina we produce. We are on schedule for installation of a condenser to remove approximately **80% of the mercury currently lost to air**. We will sell all metallic mercury as a by-product to commercial users in the United States.

Neutron Activation Analysis of Mercury in locally consumed fish

| Sample ID | Hg ($\mu\text{g/g}$) |
|------------------|------------------------|
| Red snapper | 0.05 |
| Grey snapper | 0.36 |
| Silver snapper | 0.46 |
| Kingfish | 0.64 |
| Dolphin | 0.15 |
| Marlin | 5.57 |
| <u>Rockyfish</u> | 0.30 |
| Kingfish | 0.33 |
| Octopus | 0.02 |
| Trout | 0.17 |
| <u>BangaMary</u> | 0.05 |
| BangaMary2 | 0.05 |
| Mangrove snapper | 0.49 |

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Fish laced with mercury

published: Wednesday | May 5, 2004

By **Eulalee Thompson**, *Staff Reporter*



EATING FISH is a double-edged sword. On the one hand, nutritionists say that fish is a rich source of proteins, fats, vitamins, calcium and iodine but, on the other hand, fish is turning out to be a formidable dietary source of the heavy metal, mercury. The 'culprit' fish to beware of are shark, swordfish, King Mackerel or Tilefish. The general public may be able to withstand the high levels of methylmercury that these fish harbour in their tissues but the World Health Organisation (WHO) advises that the health risks for some vulnerable groups such as pregnant women, women planning to become pregnant, nursing mothers and young children may be great.

Various international agencies have set safe limits for mercury in food in their populations. In the latest advisory on mercury in fish issued in March, the U.S. Food and Drug Administration (FDA) says persons in these vulnerable groups are advised not only to avoid high-risk fish but to eat only two fish meals (up to 12 ounces) per week using a variety of fish and shellfish with lower levels of mercury such as shrimp, canned tuna, salmon, pollock and catfish. The FDA states that albacore ('white') tuna has more mercury than canned light tuna, therefore only six ounces or less of this type of tuna should be eaten each week.



Elements in human placentae in Jamaica

C Grant^I; G Lalor^I; H Fletcher^{II}; T Potter^{II}; M Vutchkov^{III}; M Reid^{IV}

ABSTRACT

AIM: To investigate the relationships, if any, between elemental content of the placenta with age of mother, birthweight and the Apgar scores of a neonate.

METHODS: Placental samples were collected, stored at -20°C and then dried and analysed using neutron activation with the SLOWPOKE II reactor at the International Centre for Environmental and Nuclear Sciences (ICENS). A questionnaire was administered at the time of delivery to determine the level of fish consumption, numbers of dental amalgam fillings and use of cough syrups. Placental concentrations of bromine, calcium, chlorine, iron, mercury, potassium, rubidium, selenium, sodium and zinc were determined.

RESULTS: The placentae of 52 Jamaican mothers with a mean age 29 years (range 18-42 years) delivering singleton neonates with a mean birthweight of 3.1 kg (1.3 - 5.5 kg) at term were collected. With the exception of iron and bromine, all results for elemental determinations are very similar to those found elsewhere. Correlation was observed for Apgar 2 (5 minutes), calcium and zinc with birthweight, with p-values of 0.002, 0.007 and 0.07, respectively. Negative correlation was observed for the Apgar 2 and potassium ($p = 0.056$) and age of mother at birth and bromine ($p = 0.02$).

The mercury concentration in the measured placentae ($7.29 \pm 9.1 \mu\text{g/kg w/w}$) was slightly lower than the mean concentration found in the literature ($8 \mu\text{g/kg w/w}$). Approximately 93% of the measured placentae in this study are below the derived placenta upper limit of $22 \mu\text{g/kg}$. Of the 7% above the upper limit none exceeded the conservative estimated limit of $115 \mu\text{g/kg}$ at which neural developmental problems start.

CONCLUSION: The significant associations noted are of unknown clinical relevance and need further study.



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Mercury found in the womb

published: Wednesday | December 1, 2004



Eulalee Thompson

LOCAL UNIVERSITY of the West Indies' (UWI's) scientists, monitoring a small group of pregnant women, found relatively low concentrations of mercury in their placentas - the organ that provides the unborn child with nourishment.

"Based on the study results on local fish, we cannot advise Jamaican women not to eat fish during pregnancy but we would advise them to avoid the fish listed by the FDA. We would also advise them not to eat too much fish as there is still small amounts of mercury in local fish and there could be an accumulation of mercury that could cross the placenta during pregnancy," Dr. **Fletcher** said. Dr. Fletcher and the other researchers (**T. Potter, M. Voutchkov and GC. Lalor** of the International Centre for Nuclear Sciences) though agreeing that the sample size of 20 pregnant women was small, were able to identify a placenta mercury concentration ranging from 0.5 to 7mg/kg (milligram per kilogram) of total mercury which is significantly lower than the 10 to 20mg/kg, internationally identified as the risk level to foetus.

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Summary of prenatal Hg exposure in Jamaica and Trinidad & Tobago

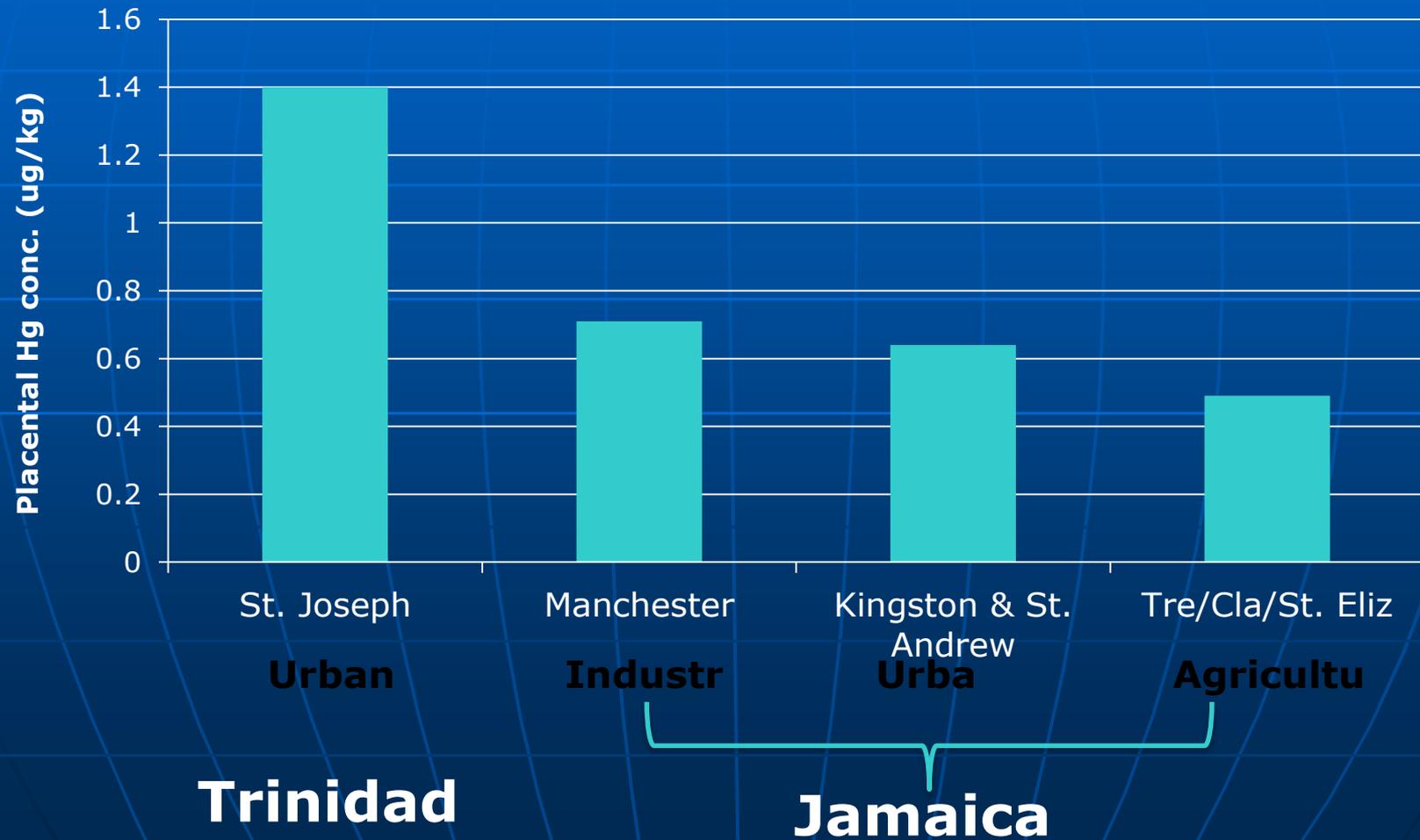
- Placenta was used as a 'dual' biomarker for both maternal and prenatal exposure to mercury
- Sources of Hg in the Caribbean
 - Fish intake
 - Environment - bauxite mining
 - Soil
- Methodology: Placenta samples were collected from different locations

| Study site (N) | Country | Description of Location | Main source of Hg |
|-----------------------------|-------------------|-------------------------|-------------------|
| Kingston & St. Andrew (100) | Jamaica | urban | Fish intake |
| Manchester (40) | Jamaica | industrial | Bauxite mining |
| Tre/Clar/St. Eliz. (40) | Jamaica | agricultural | Soil |
| St. Joseph (80) | Trinidad & Tobago | urban | Fish intake |

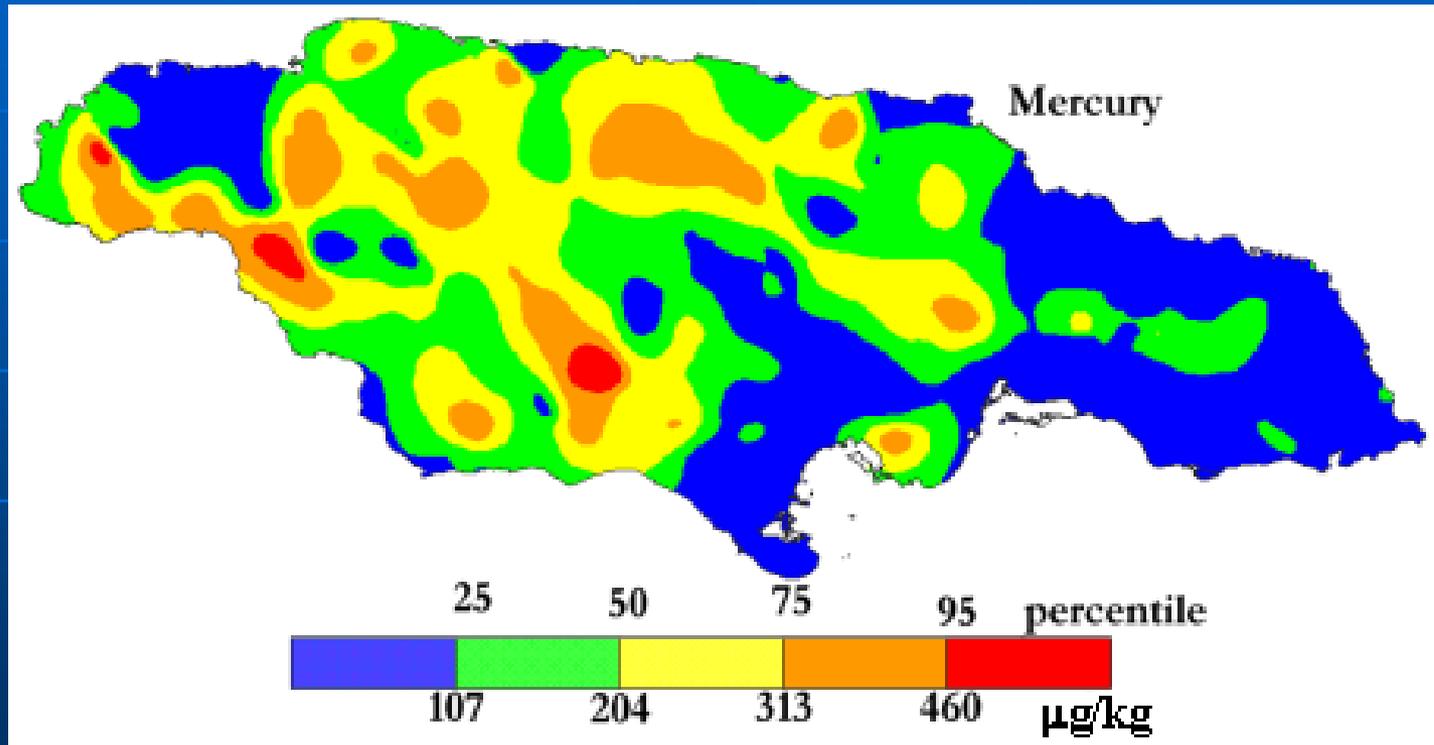
Results

- ❖ Placental Hg conc. is influenced by natural environment and fish intake

Placental Hg conc. (ug/kg) vs Description of Location



Mercury levels in Jamaican soils





Ministry Of Health
(Environmental Health Unit)

In collaboration with



University of the West Indies
(Medical Physics)

Pre-survey Questionnaire

for

Mercury Inventory in Public Healthcare Facilities

Organized by

*Bradshaw Isaacs- Environmental Health Specialist
(Occupational Health and Safety) EHU*

*Prof. Mitko Voutckov
Head of Medical Physics, University of the West Indies*

Jamaica signs historic Minamata Convention on Mercury

Saturday, October 12, 2013

4 Comments

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Robert Pickersgill, Minister of Water, Land, Environment and Climate Change signs the historic Final Act and Minamata Convention on Mercury in Kumamoto, Japan on October 10, 2013.

OTHER STORIES

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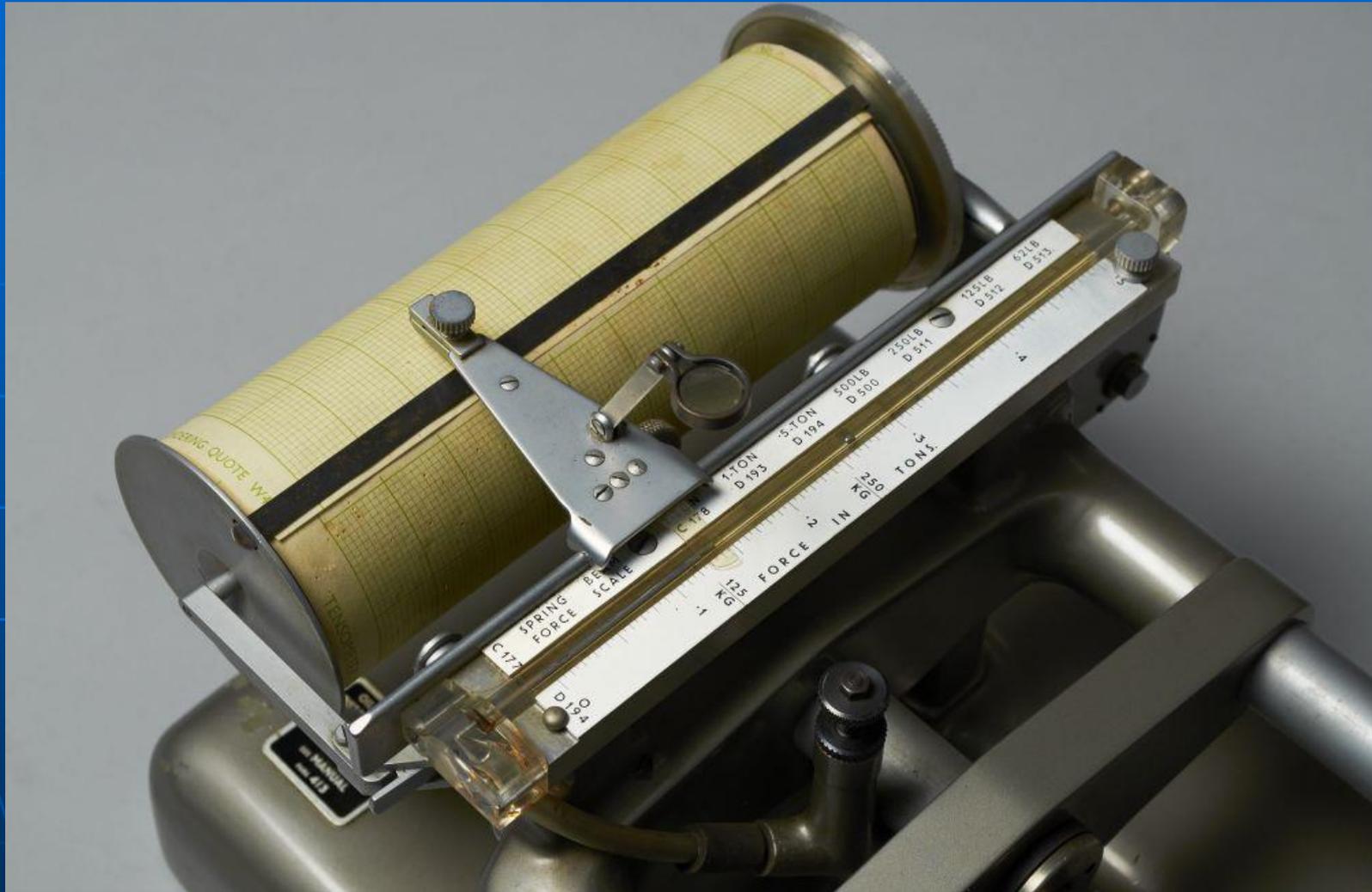
Rowley uses one-year

Electronic Tensometer

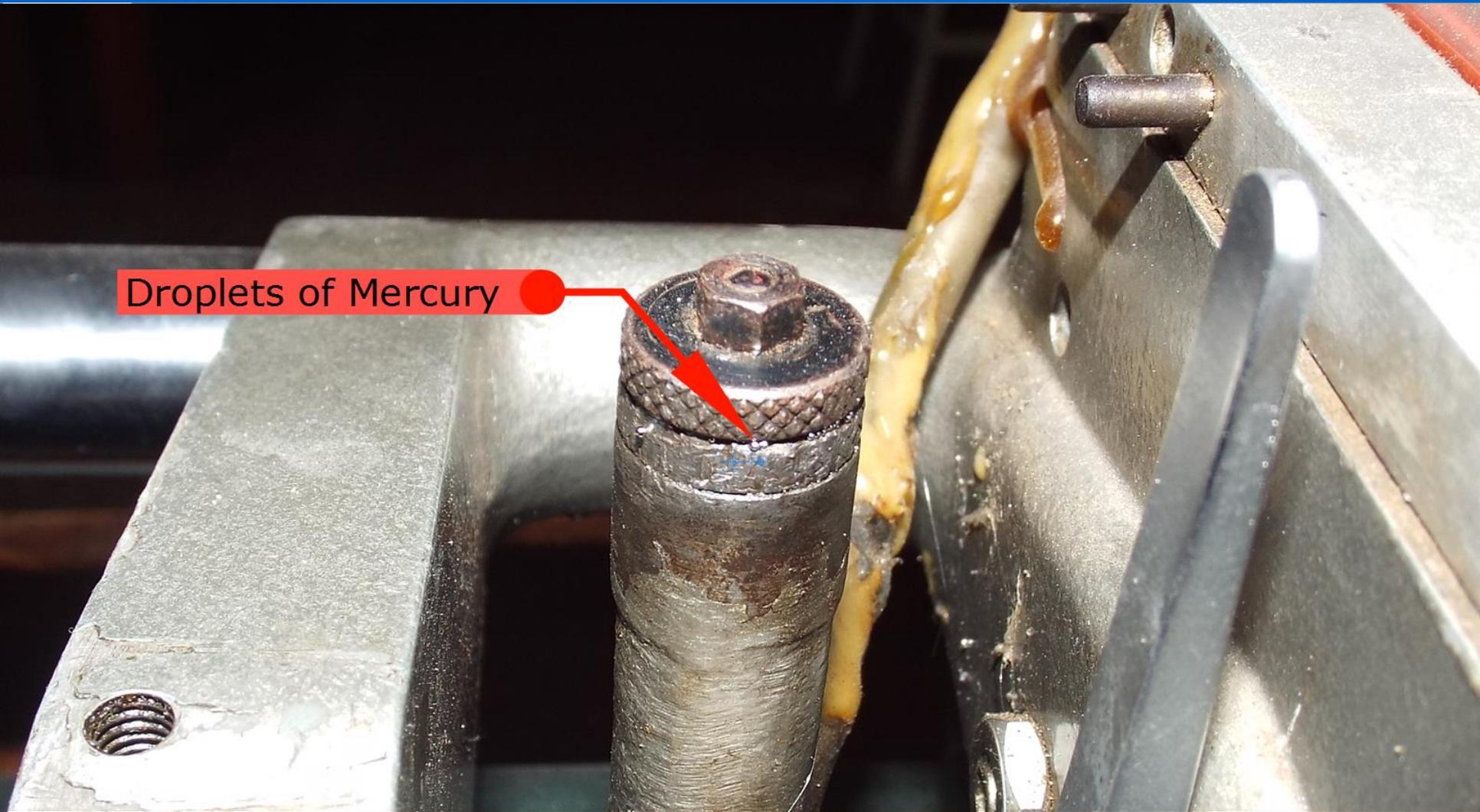


Mercury Based Tensometer





Droplets of Mercury



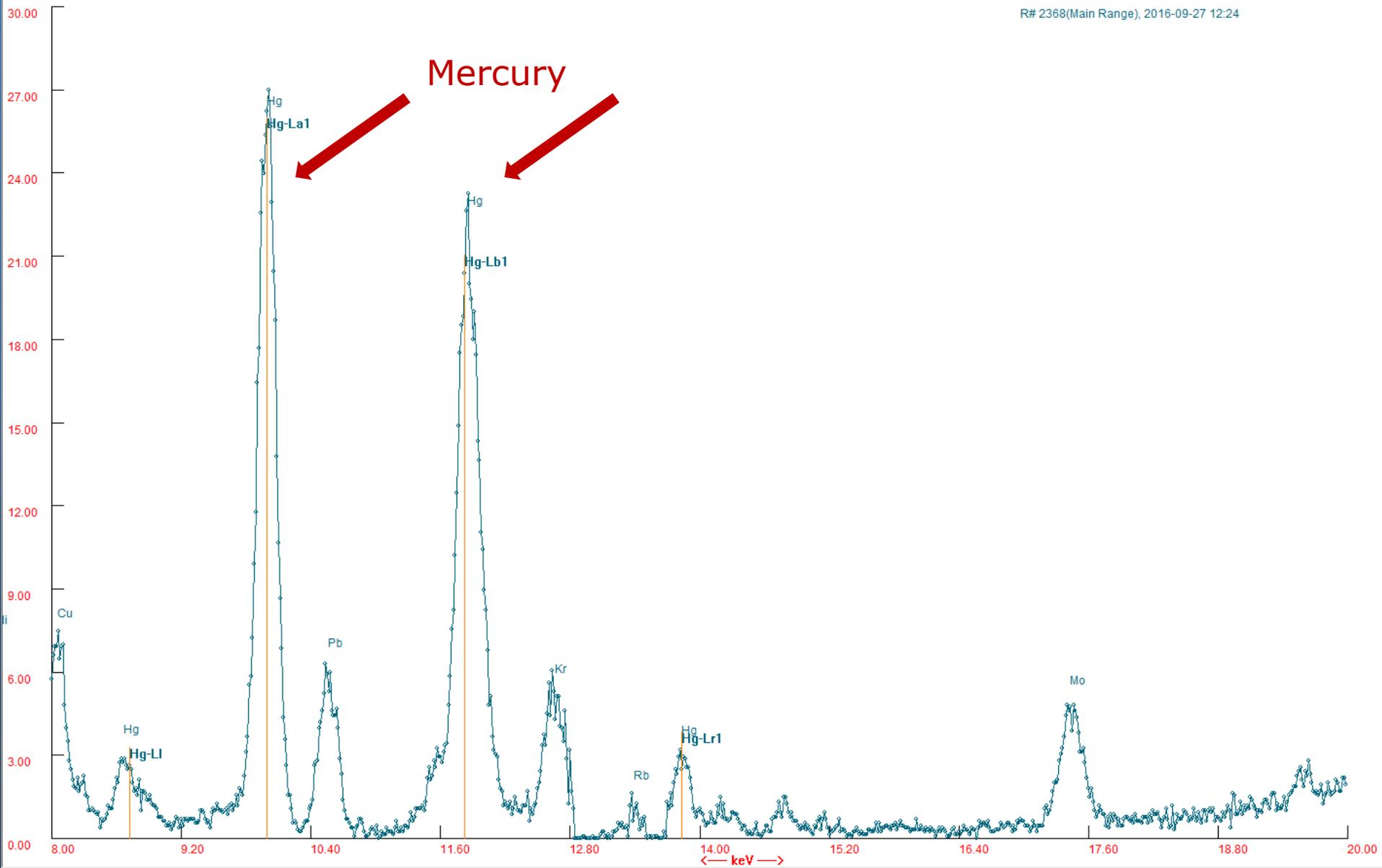
Droplets of Mercury



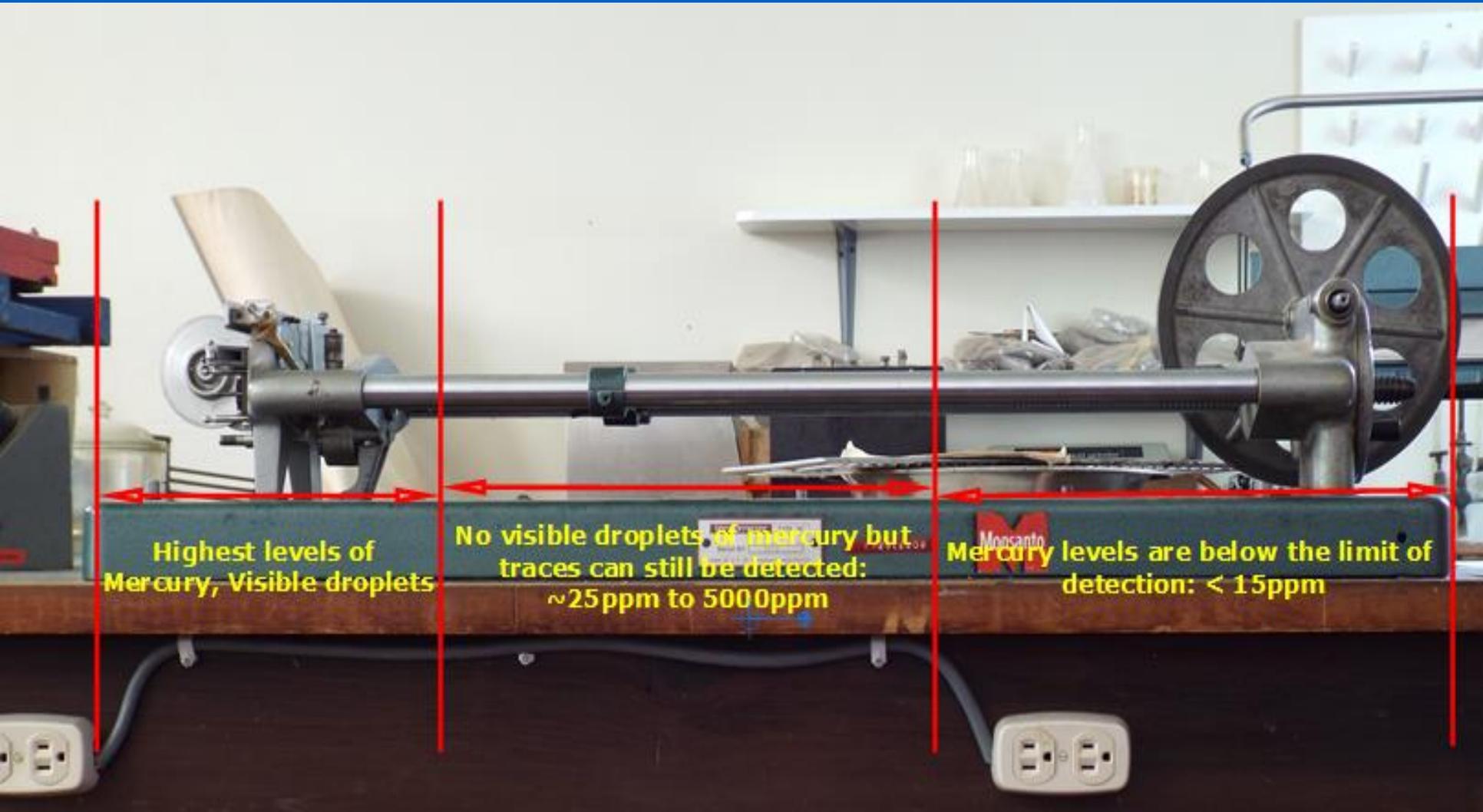
X-ray Fluorescence spectrum of mercury droplets

Counts/Sec

R# 2368(Main Range), 2016-09-27 12:24



Mercury spill mapping of an Old Tensometer



Highest levels of Mercury, Visible droplets

No visible droplets of mercury but traces can still be detected:
~25ppm to 5000ppm

Mercury levels are below the limit of detection: < 15ppm

Counts/Sec

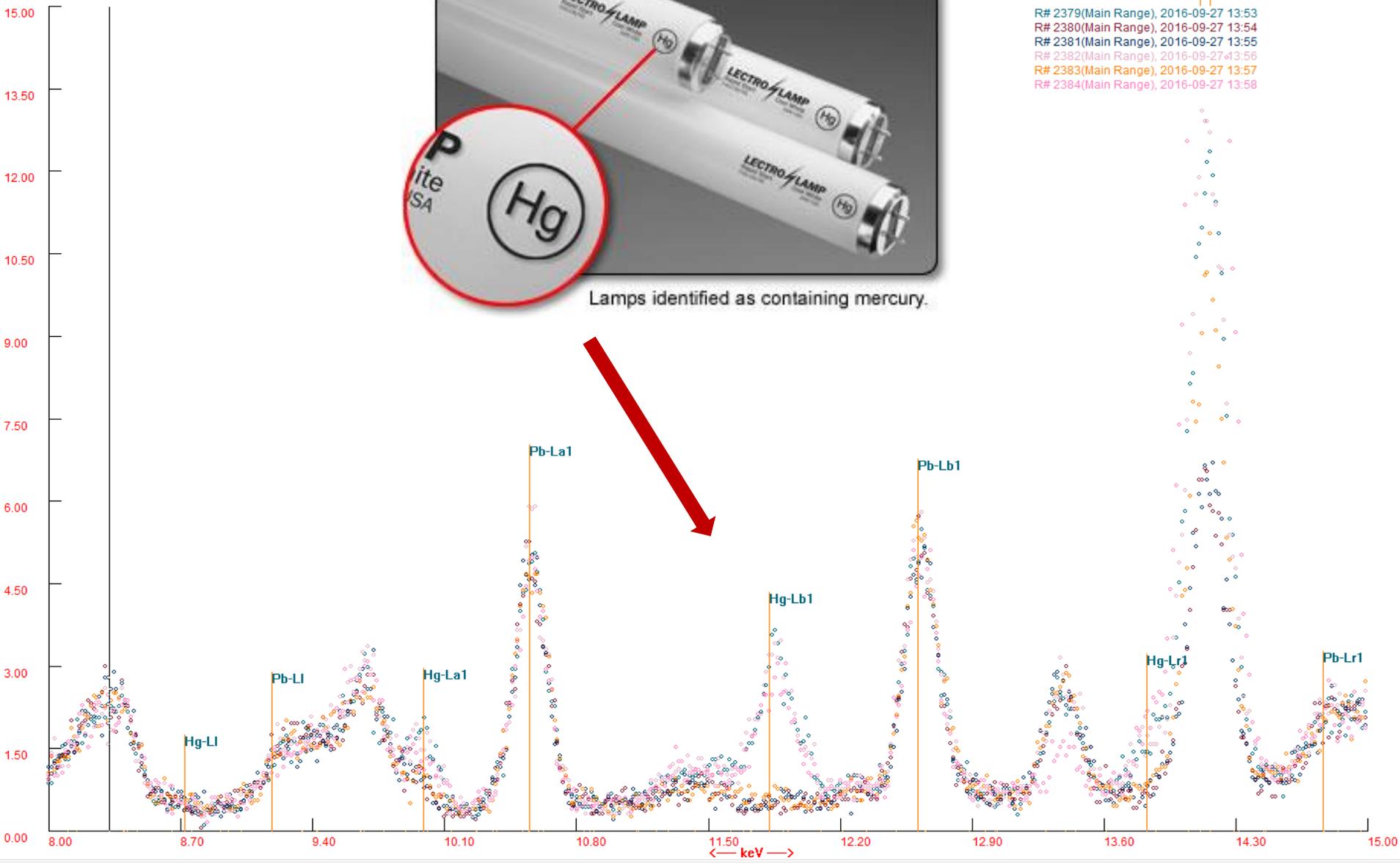


Table 1: Mercury Use in Lamps Sold by NEMA Companies in 2004

| Lamp Type | Amount of Mercury in Lamp (mg) | Percent of Lamps with Specified Mercury Amount |
|----------------------|--------------------------------|--|
| Fluorescent | 0 - 5 | 12 |
| | > 5 - 10 | 48.5 |
| | > 10 - 50 | 27 |
| | > 50 - 100 | 12.5 |
| CFL | 0 - 5 | 66 |
| | > 5 - 10 | 30 |
| | >10 - 50 | 4 |
| Metal Halide (MH) | >10 - 50 | 24 |
| | > 50 - 100 | 40 |
| | > 100 - 1,000 | 35 |
| Ceramic Metal Halide | 0 - 5 | 17.6 |
| | > 5 - 10 | 46.8 |
| | > 10 - 50 | 35.6 |
| High Pressure Sodium | >10 - 50 | 97 |
| Mercury Vapor | >10 - 50 | 58 |
| | > 50 - 100 | 29 |
| | > 100 - 1,000 | 12 |
| Mercury Short-Arc | > 100 - 1,000 | 65 |
| | > 1,000 | 23 |
| Mercury Capillary | > 100 - 1,000 | 100 |

According to the lamp manufacturers, approximately 60 percent of all fluorescent lamp types sold in the U.S. in 2004 contained 10 mg of mercury or less. The remaining 40 percent contained more than 10 mg and up to 100 mg of mercury. Lamps used in tanning equipment were reported to contain an average of 17 mg of mercury per lamp, with a high of 20 mg and a low of 5.5 mg. Germicidal lamps were reported to contain an average of 7.6 mg mercury per lamp, with a high of 70 mg and a low of 5.5 mg. All four-foot linear fluorescent lamps reportedly contained an average of 13.3 mg, with a high of 70 mg and a low of 2.5 mg. The four-foot fluorescent lamps that passed the Toxicity Characteristic Leaching Potential (TCLP)⁵ test contained an average of 5.3 mg of mercury, with a high of 20 mg and a low of 1.4 mg.

