

A map of Canada is the background, with various natural resource icons overlaid: a forest in the northwest, a body of water in the north, a mineral deposit in the west, a city skyline in the center, and a mountain range in the east.

CANADA'S NATURAL RESOURCES

NOW AND FOR THE FUTURE

www.nrcan.gc.ca

Elemental and Mineralogical Composition of Energy Deposits and Their Utilization, By-Products and Their Impact on Environment and Health

Environmental Study Group
GSC - Calgary



Natural Resources
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Overview

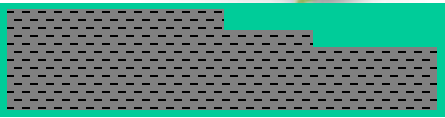
<i>Basic Issue</i>	<i>Response Elements</i>	<i>ESS Candidate Programs</i>	<i>Outputs</i>	<i>Outcomes</i>
<p>Clean Environment</p> <p>What needs to be done to safeguard Canadians from toxic substances and environmental contaminants?</p>	<p>Chemical variation in space and time.</p> <p>Processes that control availability and transfer of elements, including contaminants into water and food chains.</p> <p>Natural and anthropogenic sources of contaminants.</p> <p>Protocols and methods for environmental and water quality assessment.</p> <p>Risk management strategies for sustainable development of natural resources.</p>	<p>Assessment of HPs emitted from natural energy deposits and energy processing facilities.</p> <p>Integration and interpretation of the potential redistribution of metals in lake sediments.</p> <p><i>Modelling of the geochemical partitioning of elements in soil.</i></p> <p>Monitoring deposition of HAPs and particles into Canadian surface environment</p> <p>Canada Wide Standard for Mercury Emission and Speciation of As, Cr, Hg, Ni from coal-fired power plant.</p> <p>Assessments of Canadian energy deposits and development of database.</p>	<p>A number of external papers outlining the mass-balance of HPs with particular emphasis on mercury from coal-fired power plants.</p> <p>Publications of the papers on variation of elements and their interaction with organic matter in central Alberta, Rouyn-Noranda (Quebec) and Belledune (New Brunswick).</p> <p>Completion of Ph.D. study " <i>Environmental Geochemistry and petrology of the recent sediment from the lakes in the vicinity of the coal-fired power plants in Central Alberta, Canada</i>".</p> <p>Completion of study of distribution of elements in topsoil around the anthropogenic point sources.</p> <p>Completion of a Ph.D. Thesis "Elemental characteristics of organic deposits from an area surrounding a Lead-Zinc smelter: concentration, distribution, mode of occurrence and mobility.</p> <p>Publications of papers on speciation of As, Cr, Hg and Ni emitted from power plants and role of carbon (char) in capture of Hg. The mitigation strategies for reduction of Hg prior to combustion.</p> <p>A data base on elemental composition of Canadian coal is being compiled</p>	<p>Provide briefing to ADM and DM on emission of mercury from coal-fired power plants in Canada.</p> <p>Provides data for possible use by Environmental agencies in Canada for determination of anthropogenic and geogenic sources and possible contaminant.</p> <p>Participated in activity of the <i>Clean Air Strategic Alliance (CASA)</i>, in Alberta as related to deposition of particle and elements on soil. The results were used in the assessment of power plant expansion in Alberta and by environmental agencies and in trans-boundary dispute.</p> <p>Provide data for the Canada Wide Standards for Hg emission and also for speciation of Ni for use in National Guideline.</p> <p>The data will be used for risk management decisions taken in accordance with the provincial and federal <i>Toxic Substances Management Policy</i> Such as delineation of high input of Pb and Zn in Columbia River valley area of B.C.</p>



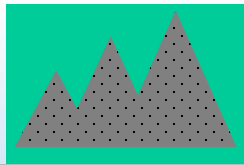
Introduction



Coal seam

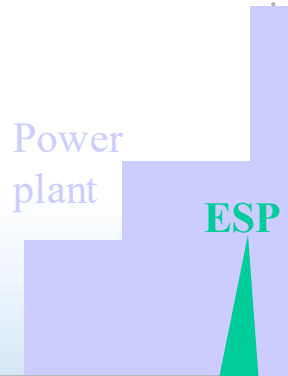


Feed coal



Power plant

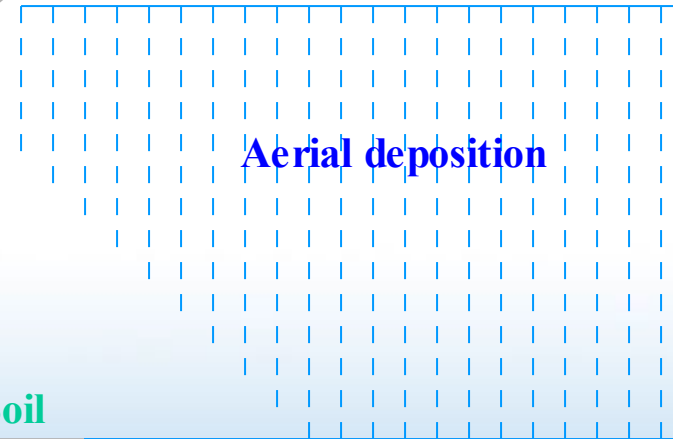
ESP



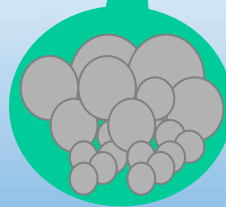
Stack emission



Aerial deposition



Soil



Lake sediments



Pre-combustion process

1. Trace elements in coal seams
2. Geochemical study of feed coal

In-process studies:

1. Geochemical study of fly ash
2. Geochemical study of bottom ash
3. Stack emission study (gaseous, particles)

Environmental impact:

1. Aerial deposition of particles (moss-monitoring)
2. Wet deposition of Hg
3. Soil study
4. Lake sediments



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Environmental Aspects of Energy Deposits Exploitation- Coal fired-Power Plants and Other Large Stationary Sources

Activities:

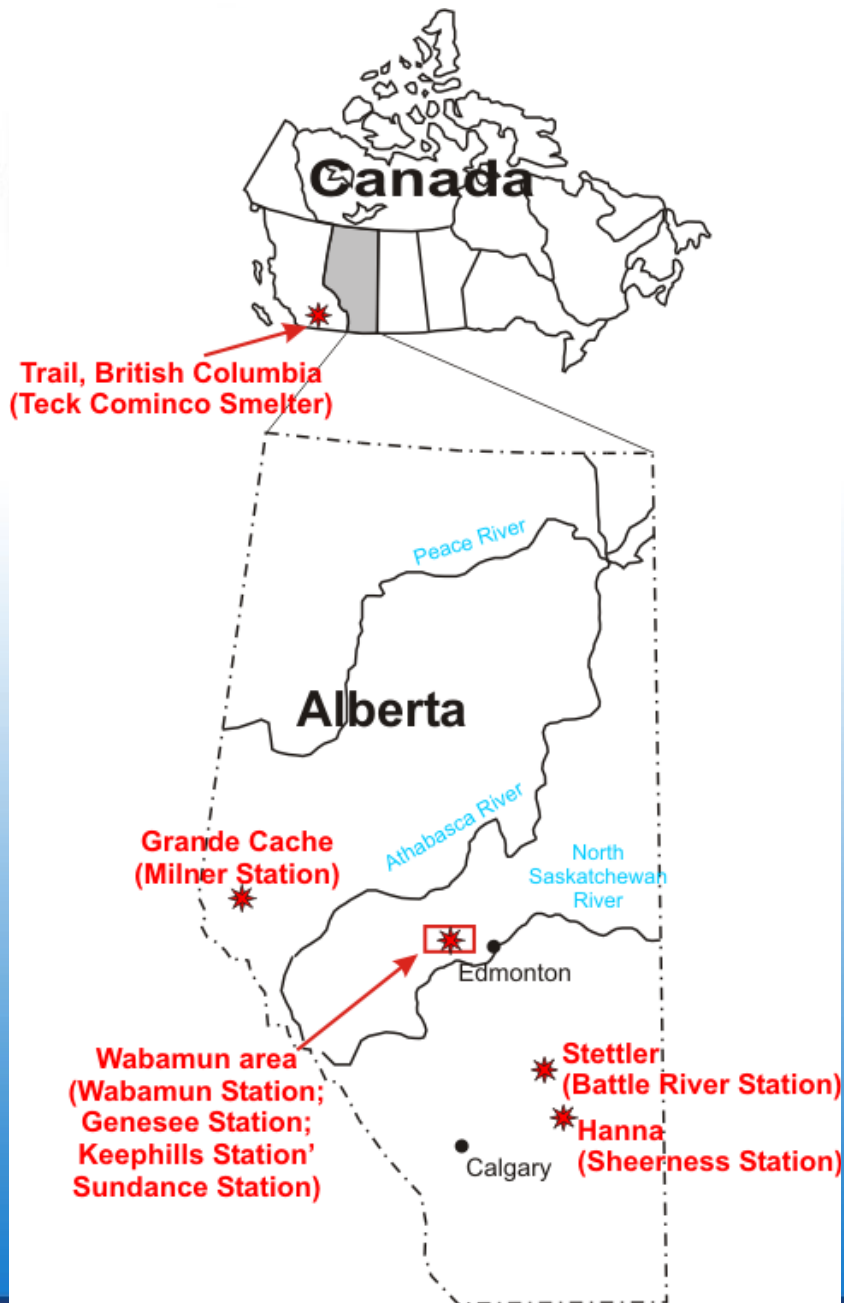
Environmental assessment of In-situ coal seams

Reduction of emitted mercury

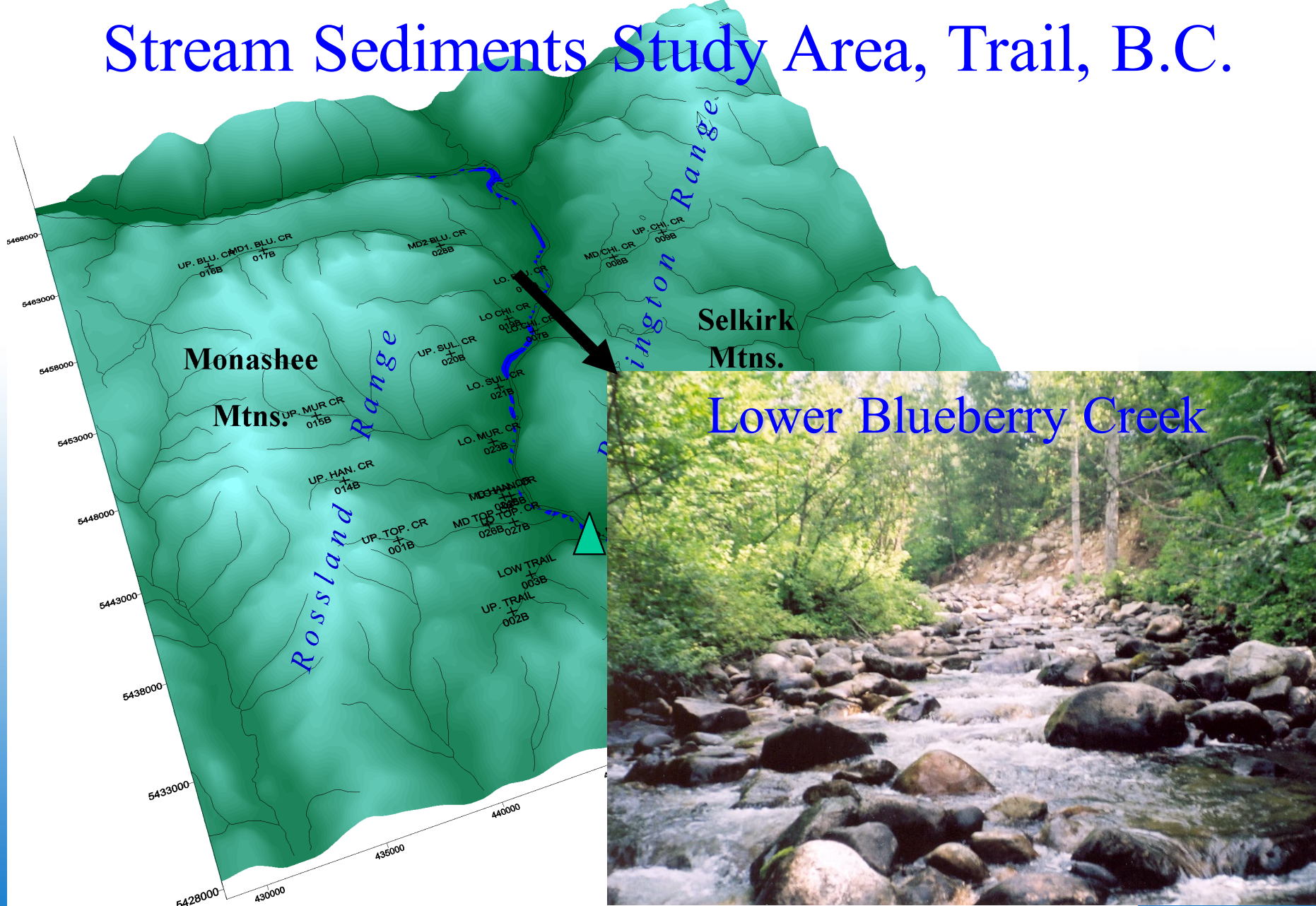
*Monitoring of particle and elements emission and deposition
(including Hg) in the vicinity of large stationary sources
(coal-fired power plants and smelters).*

*Monitoring input of elements and particles in lakes and
streams in the vicinity of large stationary sources .*

Particle and element monitoring projects in British Columbia and Alberta using moss bags



Stream Sediments Study Area, Trail, B.C.



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Accomplishment

- **Provide briefing to ADM and DM on emission of mercury from coal-fired power plants in Canada.**
- **Minister received letters of appreciation and support from industry in regards to our activities**
- **Participated in development of guideline for the Canada-wide Standard for Mercury and supplied the results to Environment Canada.**
- **The ESS method for pre-combustion reduction of mercury through selective mining and use of natural char (Inertinite) was accepted by Mercury Expert Committee (MEC) in their meeting (May 24 -25, 2005, Ottawa) and put forward to consideration by IEA in Paris.**

Participated in Canada-wide Standard of Mercury emission from coal -fired power plant

Outcomes

- **The data on *the Canada -wide Standards for Hg emission* was used for National Guideline. Published in *Canada Gazette*, 2005, Vol.139, No30, Part 1, DEPARTMENT OF THE ENVIRONMENT, Canadian Environmental Protection Act, 1999. Agreement respecting the Canada –Wide Standard for Mercury Emissions from Coal fired Electric Power Generation Plants. Stephan Dion, Minister of the Environment.**

Accomplishment

- Completed the the studies on speciation of As, Cr, Hg and Ni emitted from coal fired power plants and submitted the results to Environment Canada.
- Completed the the study of elements in topsoil around power plants

Accomplishment

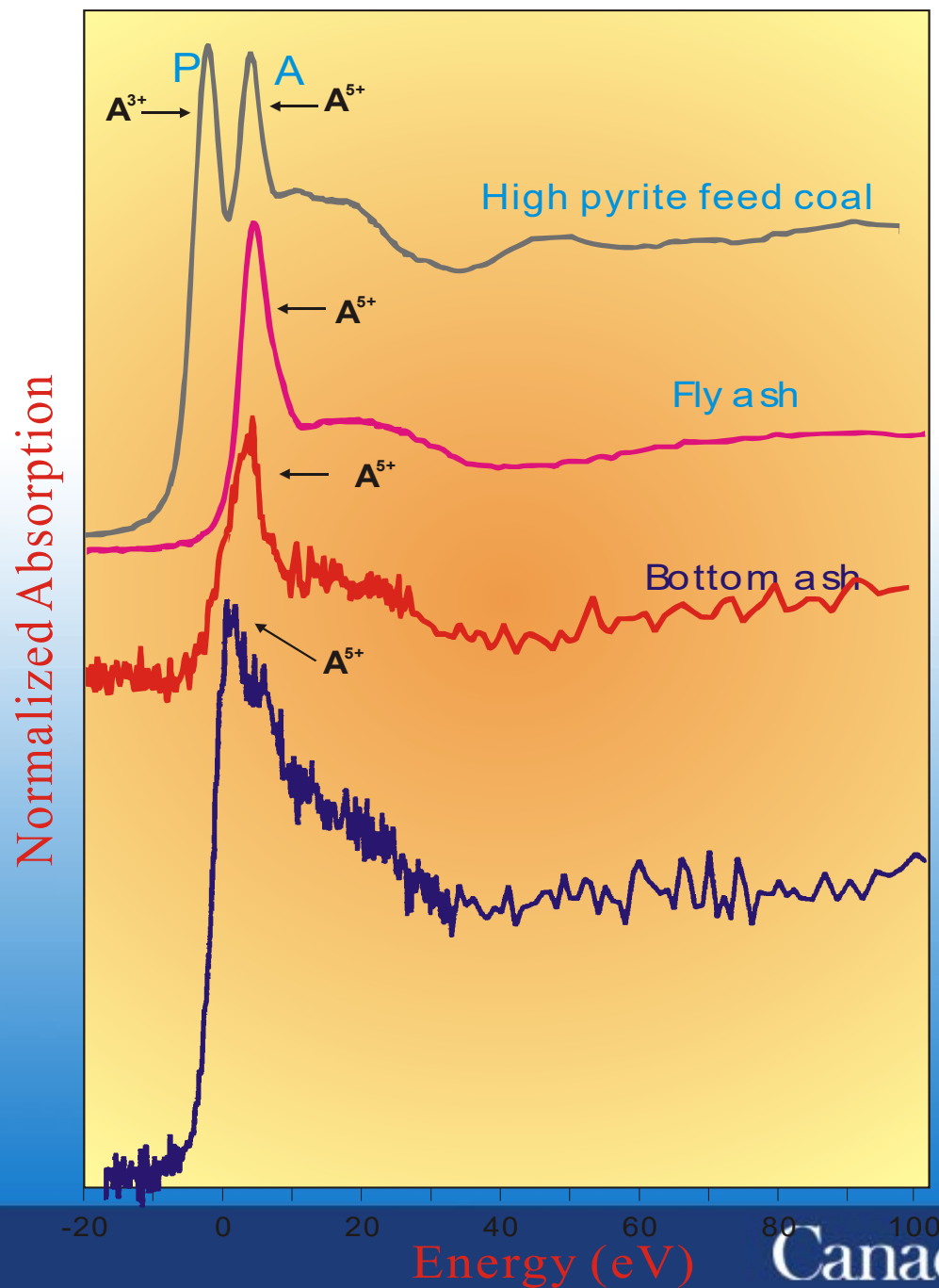
- **Advised, ATCO, EPCOR, Manitoba Power, Nova Scotia Power, Ontario Power, Saskatchewan Power, TransAlta Utilities, Western Canadian coal-mining Companies, Shell, ENCANA, Tack –Cominco Smelter, Coal mining Companies, Consulting Companies such as SECOR Environment, CANTEX, Golder, AXYES Environment, and Public at large concern about environment, on daily bases.**

Accomplishment

- Supervised and completed two Ph.D theses
- Presently supervising two M. Sc and two Ph. D
- Publication of 23 papers in J. Coal Geology, Energy and Fuel, Fuel, JEM, 10 Conference Proceedings and 26 abstracts and posters.
- Designed, coordinated and delivered (with L. Snowden and V. Stasiuk) a postgraduate course (36 hours) for Dept. Chem.Eng, University of Calgary.
- Elected the coordinator of “Innovation” for ICCP.



Arsenic Speciation



The mitigation strategies for reduction of Hg prior to combustion

Role of carbon (char) in capture of Hg.

Outcomes

- Char in fly ash can capture up to 60% of input of mercury

Reduction/health

Outcomes

- **Mercury emitted from coal fired power plants can be reduced up to for example from 135 kg/y to 87 kg/year and from 94 kg/year to 39 kg/year.**
- **The total Hg emitted from coal-fired power plants are 1180 kg/y for Alberta and 2695 kg/y in Canada (Canada Gazette, 2005).**
- **Then 103 kg/y reduction of mercury in Alberta from 1180kg/y to 1077 kg/y is good!**



Mercury Wet Deposition Study

A Collaborative Study Between NRCan-ESS & CASA

The Clean Air Strategic Alliance (CASA)

We joined this group upon direction and recombination of ADM

CASA consists of the senior representatives from:

- **Public (concerned citizens)**
- **Alberta Environment**
- **Environment Canada**
- **Industry (Coal-mining , Coal fired power plants, Pulp and Paper, Oil and gas producing).**
- **Non-government organizations (including health and environmental groups)**



The Geographic Boundaries of the Alberta Airsheds

1. **Fort Air Partnership (FAP)**
(Fort Saskatchewan and region)
2. **Palliser Airshed Society (PAS)**
(Medicine Hat and Redcliffe)
3. **Parkland Airshed Management Zone (PAMZ)**
(Red Deer, Rocky Mountain House, Sundre, Banff and surrounding regions)
4. **Peace Airshed Zone Association (PASZA)** (Grande Prairie and region)
5. **West Central Airshed Society (WCAS)** (Jasper, Hinton, Edson, Lake Wabamun, Drayton Valley, Pigeon Lake and surrounding regions)
6. **Wood Buffalo Environmental Association (WBEA)** (Fort McMurray and the Wood Buffalo region)

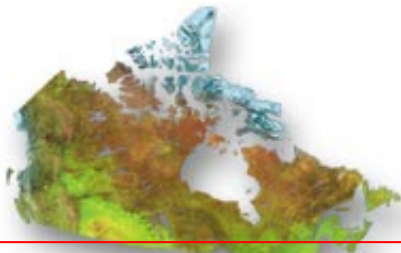


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Map is modified from the official
website of the Clean Air Strategic
Alliance (CASA)

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Was all these studies use to anyone?

Outcomes

- The calculated input of elements of environmental concern (As, Cd, Hg, Ni, and Pb) emitted in the air (ng/m^3) by the power plant at the zone of maximum impact and at ground level are lower than the *Health Guidelines in Canada and the USA*.
- The findings of moss monitoring study around the Wabamun station *was a key document in a EUB (Energy Utility Board) hearing for expansion of TransAlta Keephills power plants.*
- The result of the moss-monitoring survey in Trail is the key data for *Environmental Risk Assessment* around Trail smelter.
- The results of stream sediment and background studies have been the significant base for the Environmental Risk Assessment study of the Trail area for Teck-Cominco and are also used as reference in *EPA report for lake Roosevelt*.





Environmental Assessment

Coordinated by *M. Burgess*

- Brooks Coal-fired Power plants
- Extension of Sundance Coal-fired power plant

Coordinated by *M. Walter, MIMS Sector*

- Dispute on Lake Roosevelt US-Teck Cominco





What Next

The New Health and Environment Program

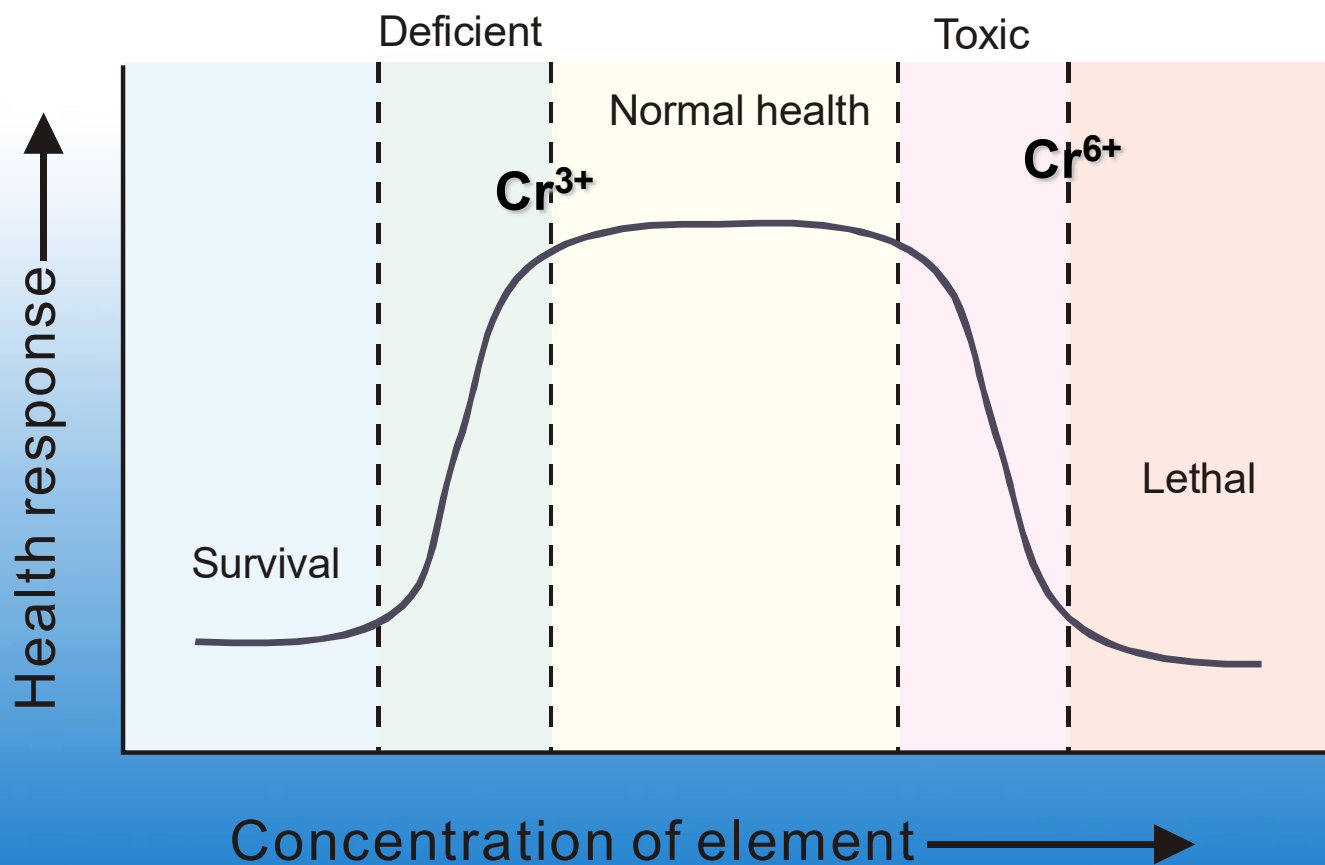
*Moving forward towards what we thought could
and should be done in second phase of MITE*

- Expansion of monitoring program to north Yukon, Arctic
- Participation in second phase of Canada-wide reduction of mercury emitted from coal fired power plant.
- Monitoring of the anthropogenic impact on land (soil) and water (lakes and stream) in Canadian surface.
- Health impact study (elements & PAHs) of produced water from CBM and Tight Gas exploration and self burning coal seams
- Participation in Environmental Assessments
- International activities as related to reduction of health hazard elements (Hg As, Cr) in China , India, Greece, The Netherlands and USA.

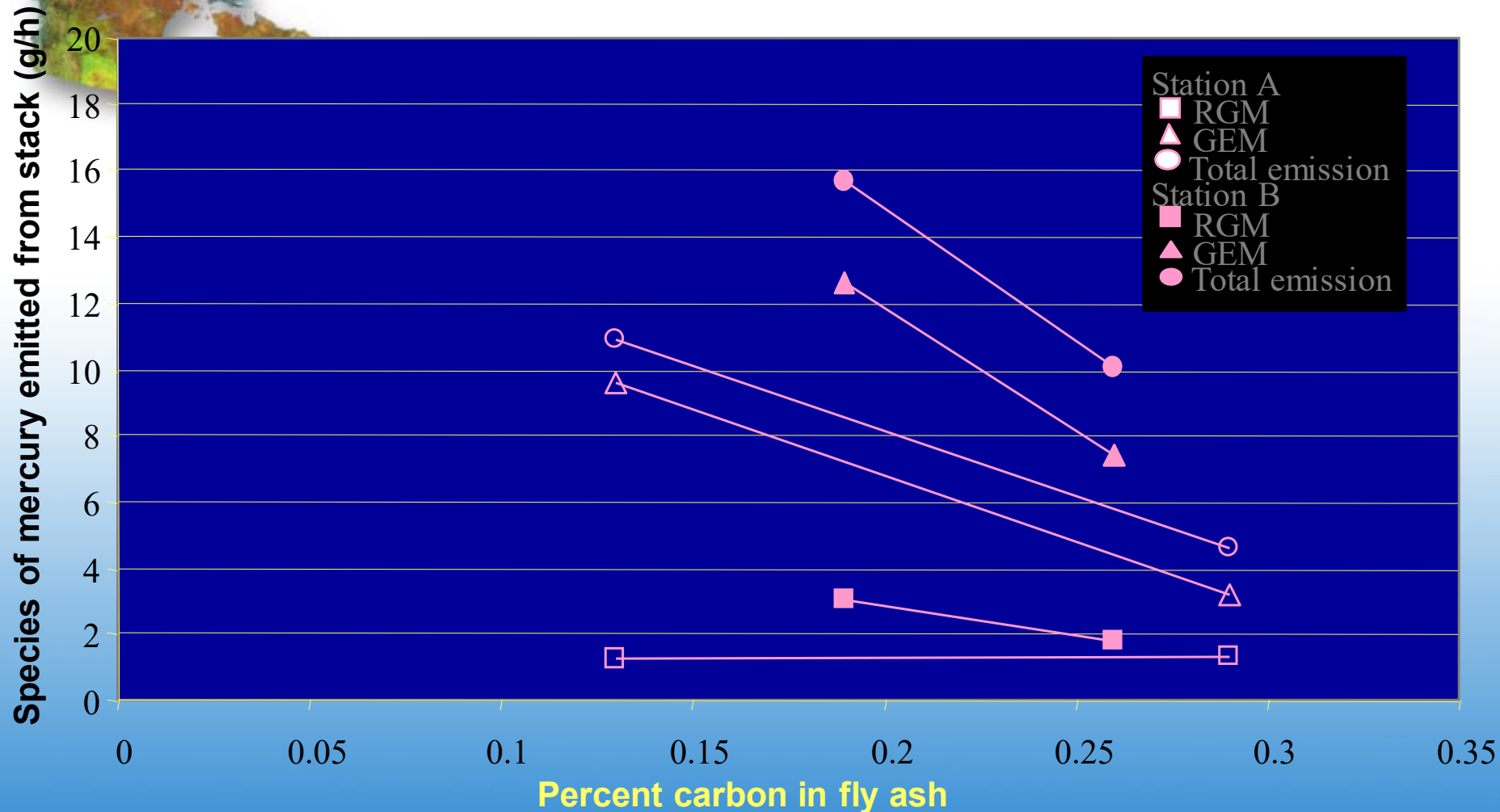




Health effects of elements (Swaine and Goodarzi 1995)



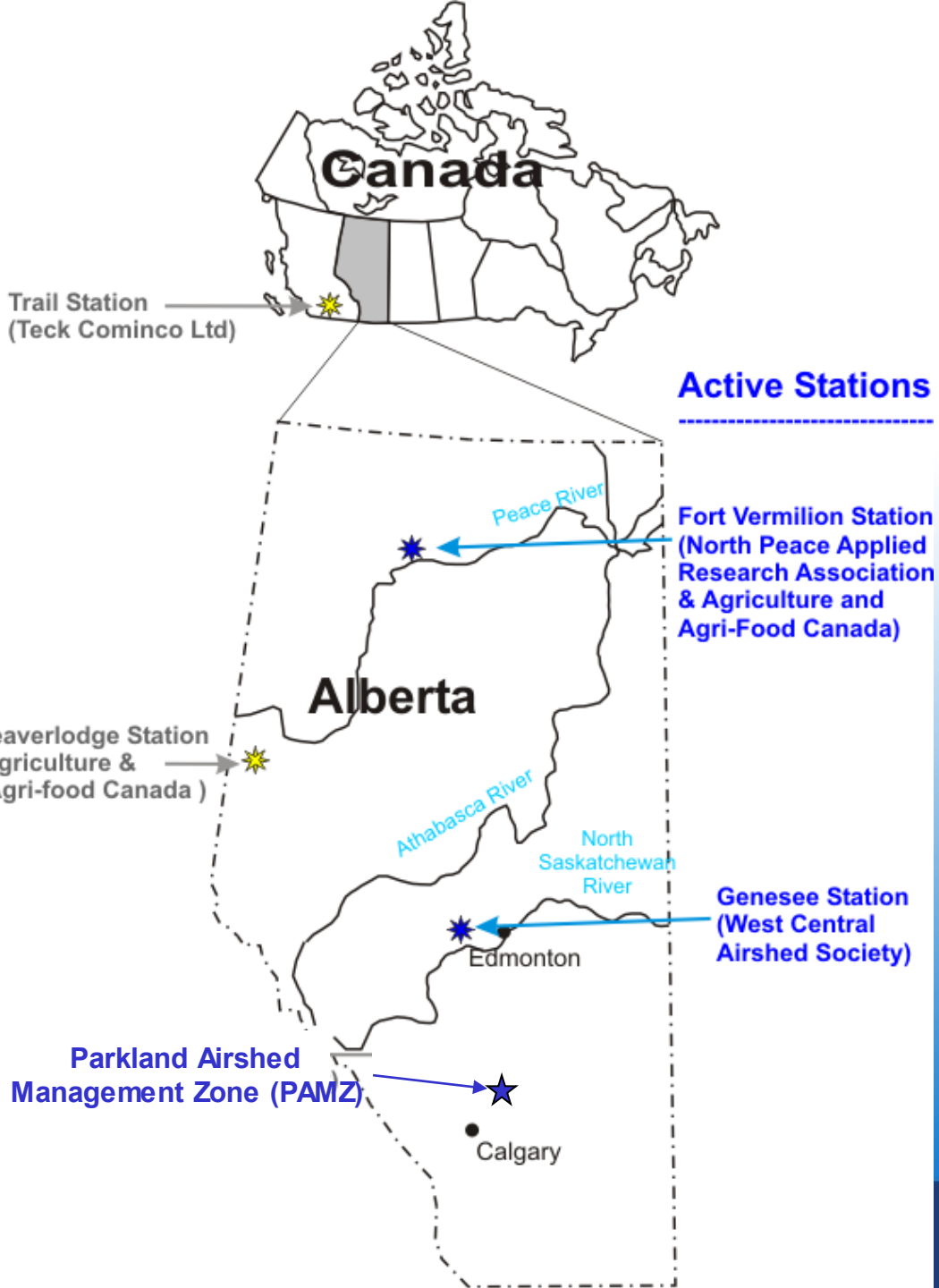
Reduction of Emitted Mercury –Influence of Selective Mining



Reduction of Mercury –Influence of Selective Mining

We were able to reduce emitted mercury from 94kg/y to 39 kg/year by removing high mercury component of coal seams used as feed coal. Most of reduced mercury is from gaseous elemental mercury fraction

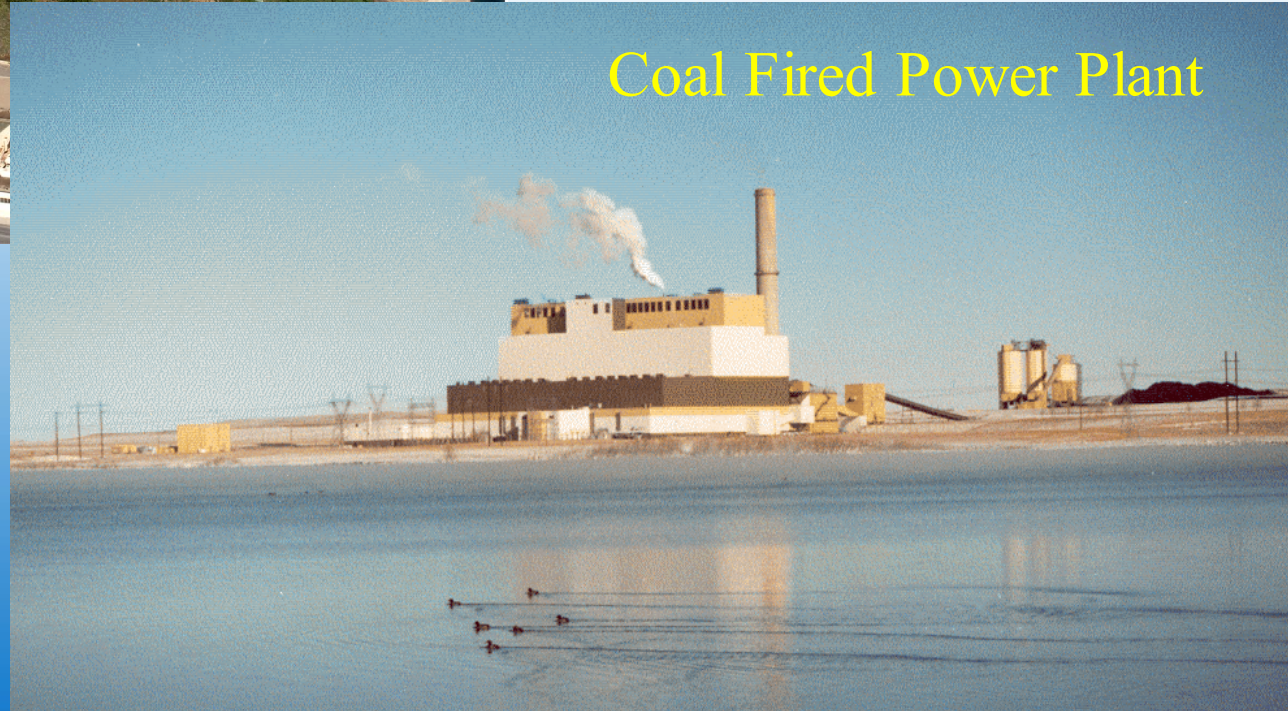
The existing Mercury Wet Deposition Stations





Pb and Zn Smelter

Particle and element monitoring projects in British Columbia and Alberta



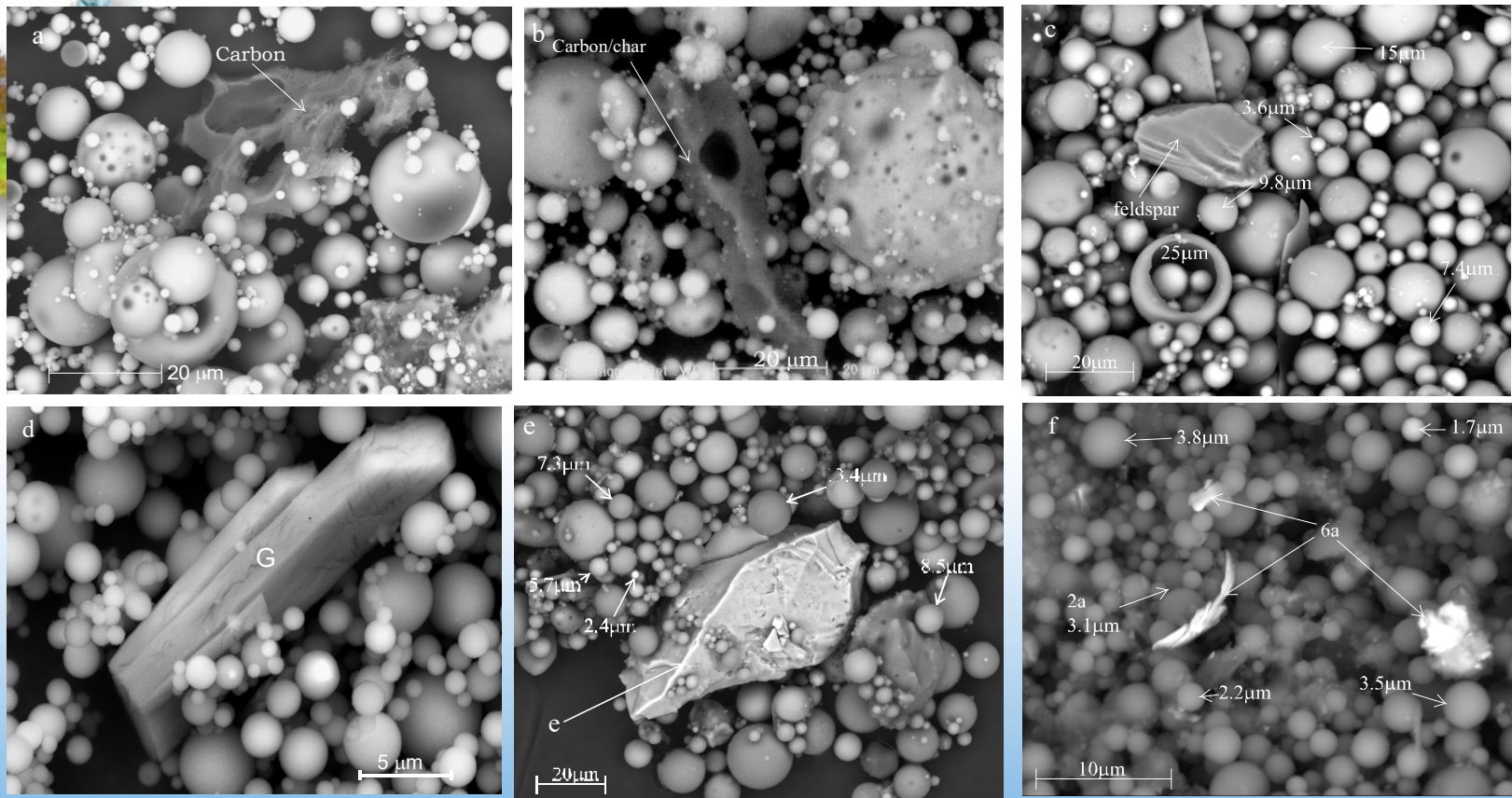
Coal Fired Power Plant



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Typical particles emitted from coal-fired power plants. SEM/EDX, carbon coated, natural surface.

The total particles emitted from modern coal-fired power plant in this studies are 0.041 and 0.044 kg/MWh, which is below the current guideline of 0.095 kg/MWh.