Advanced Analytical Services for the Determination and Characterization of

Selected Selenium Species

Analytical Services Division

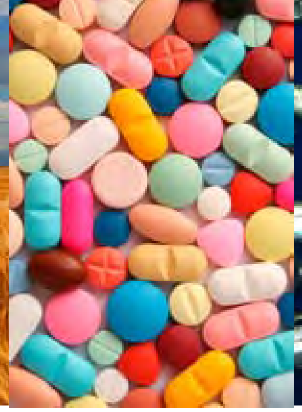
Brooks Rand Labs

Meaningful Metals Data








34 78.96

Se

[Ar] $4s^2$ $3d^{10}$ $4p^4$

Although selenium is a component of many minerals, it is only the seventieth most abundant element in the earth's crust and occurs mostly in small crystals and in small quantities. It typically only occurs at elevated concentrations in the environment as a byproduct of anthropogenic activity.

An essential micro-nutrient, selenium becomes toxic to most eukaryotic organisms at relatively low concentrations. While selenium's basic biogeochemistry determines its natural distribution in the environment, historically, research on selenium has focused almost exclusively on total recoverable concentrations in soils, sediments, water, and plants.

Whereas such data is invaluable in establishing relative concentrations, it does very little to further understanding of how selenium cycles through the environment and the ultimate fate and effect of the rapidly increasing quantities being introduced by modern agricultural, mining, and energy generation practices.

Individual inorganic valence states and organic selenocompounds behave entirely differently depending on their specific characteristics. Furthermore, bioavailability and therefore toxicity are highly contingent on the selenium species in question.

An understanding of which selenium species are present in a wide range of matrices, including water, soil, sediments, wildlife, pharmaceuticals, dietary supplements, human urine, blood, and serum, and industrial wastewater streams, can be crucial when making important decisions regarding human health and the environment.

Brooks Rand Labs offers highly advanced analytical services for the determination and characterization of selected selenium species by our customized methods coupling high performance liquid chromatography (HPLC) with inductively coupled plasma – mass spectrometry (ICP-MS), employing optimized dynamic reaction cell (DRC) parameters.

Inorganic Species
selenite (CAS 14124-67-5)
selenate (CAS 14124-68-6)

This HPLC-ICP-DRC-MS configuration allows for multi-element and multi-isotopic detection, high sensitivity, a wide linear dynamic range, and minimal polyatomic interferences. This allows us to separate and quantify selected selenium species in even the most complex matrices while maintaining ultra-low detection limits.

To learn more about our innovative and customized analytical methods and how they can benefit your projects, contact us today.

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Wastewater Treatment

Coal, oil, and metals extracted from geological formations including seleniferous shale often contain excessive amounts of selenium.

As a result, process and wastewater streams from mining operations, petroleum refineries, and coal-fired power plants can contain highly elevated concentrations of selenium, far exceeding many discharge limits.

Removal of selenium from these wastewater streams often presents a significant challenge as the effectiveness of most treatment processes relies heavily on the prevalence of a particular selenium species.

For example, while there are numerous commercial technologies available for the treatment of selenite, only anaerobic biological reactors have been shown to be effective in removing selenate.

During the refining of crude oil, relatively large amounts of hydrogen selenide and selenocyanate are formed that persist in the process water.

Whenever cyanide leaching is utilized in the mining industry, a complex is quickly formed with selenium to create selenocyanate. Moreover, power plants that utilize flue gas desulfurization systems often produce wastewaters that contain selenite, selenate, selenide, selenocyanate, methylseleninic acid, and various other organic selenocompounds.

Organic Species
selenocyanate (CAS 5749-48-4)
methylseleninic acid (CAS 28274-57-9)
dimethylselenide (CAS 593-79-3)
trimethylselenonium ion (CAS 25930-79-4)

An understanding of which selenium species are present in a wastewater stream can be invaluable when determining the appropriate treatment method to efficiently remove selenium and meet discharge regulations.

Wildlife Monitoring

While selenium deficiency has long been a concern for animal husbandry, selenium poisoning of wildlife is increasingly becoming recognized as an environmental crisis.

Activities such as mining and irrigation agriculture often cause anthropogenic disturbances of seleniferous geological formations. Coal-fired electricity generation and petroleum refining can also cause elevated levels of selenium to be mobilized into aquatic ecosystems. Well documented examples of these disturbances and point-sources have led repeatedly to episodes of widespread wildlife poisoning.

Research into the toxicology of selenium has shown that the thresholds for selenium-induced reproductive toxicosis among oviparous vertebrates, such as fish and water birds, can be less than one order of magnitude greater than nutritional requirements. Moreover, specific species of selenium have widely varying levels of toxicity to different forms of wildlife.

Inorganic selenium species like selenite have been found to be up to 500 times more toxic than common organic selenocompounds. Certain species of vegetation have proven to be able to accumulate and synthesize extremely large amounts of selenium, and when used in phytoremediation studies have rendered compromised habitats (uplands and wetlands) significantly improved.

An understanding of which selenium species are present in an ecosystem can be critical when establishing the vulnerability of wildlife to selenium exposure, threshold exposure-response relationships, and the limits of environmental tolerance.

Human Health

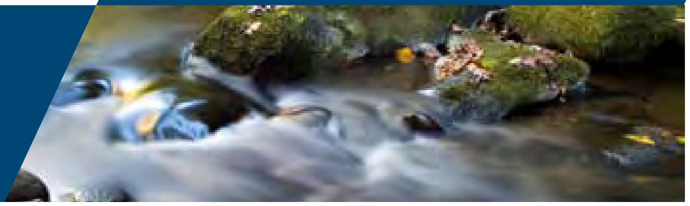
Selenium is an unusual element as it relates to human health in that it is an essential micro-nutrient necessary for the biosynthesis of selenocysteine (an amino acid incorporated into selenoproteins) while also being toxic at only marginally greater levels than what are required for normal health.

The acute selenium toxicity levels and causes of chronic selenium poisoning (selenosis) in humans are highly dependent upon the bioavailability and metabolization of the selenium species examined. Similarly, selenium deficiency, which is associated with several diseases, is most effectively resolved by the introduction of supplements containing those selenium species most conducive to incorporation into essential selenoproteins.

Selenoaminoacids & Selenoproteins
selenomethionine (CAS 3211-76-5)
selenocysteine (CAS 3614-08-2)
selenocystine (CAS 1464-43-3)
Se-methylselenocysteine (CAS 26046-90-2)
selenohomocysteine (CAS 29412-93-9)
selenocystamine (CAS 3542-13-0)
selenocystathionine (CAS 2196-58-9)
γ-glutamyl-*Se*-methylselenocysteine

Selenium has been claimed to reduce the incidence of a range of cancers and to have beneficial effects on AIDS symptoms, male fertility, skin disorders, anxiety, and asthma. Characterization of selenium species is critical for a better understanding of the role of selenium in human health and disease. An understanding of which selenium species are present in pharmaceuticals, dietary supplements, urine, blood, and serum can be critical when establishing bioavailability, nutritional value, toxicity, and metabolic behavior.

Total Recoverable Selenium



Selenium in the environment is a matter of growing concern but few appreciate how difficult it can be to acquire accurate data regarding its concentration. Analysis for total recoverable concentrations by conventional ICP-MS techniques is extremely prone to mass spectral interferences. The presence of argon, chloride, calcium, or bromide can be mistaken for one or more of the six isotopes of selenium. Without an analytical technique to eliminate the interferences that lead to elevated results, decision makers might be acting on inaccurate data.

Isotope	Interference	Source
^{74}Se	$^{37}Cl^{37}Cl$	Chlorides can be at high concentrations in many matrices.
	$^{38}Ar^{36}S$	Sulfides can be at high concentrations in many matrices.
^{76}Se	$^{40}Ar^{36}Ar$	Argon dimers are formed from the ICP-MS plasma gas.
	^{76}Ge	Germanium is commonly used as an internal standard.
^{77}Se	$^{40}Ar^{37}Cl$	Chlorides can be at high concentrations in many matrices.
^{78}Se	$^{40}Ar^{38}Ar$	Argon dimers are formed from the ICP-MS plasma gas.
	^{78}Kr	Krypton is a common contaminant in an argon gas supply.
	$^{38}Ar^{40}Ca$	Calcium can be at high concentrations in many matrices.
^{80}Se	$^{40}Ar^{40}Ar$	Argon dimers are formed from the ICP-MS plasma gas.
	$^{32}S^{16}O_3$	Sulfides can be at high concentrations in many matrices.
^{82}Se	^{82}Kr	Krypton is a common contaminant in an argon gas supply.
	$^{40}Ar^{42}Ca$	Calcium can be at high concentrations in many matrices.
	$^{12}C^{35}Cl_2$	Chlorides can be at high concentrations in many matrices.
	$^{34}S^{16}O_3$	Sulfides can be at high concentrations in many matrices.

At Brooks Rand Labs, we employ ICP-MS equipped with dynamic reaction cell (DRC) technology to overcome mass spectral interferences and thereby produce highly accurate data in even complex matrices. With DRC technology, gas-phase reactions take place that can remove the source of the interferences or derivatize the analyte of interest to a mass that won't be mistaken for one of the common interferences.

Panayot "Pepi" Petrov, PhD

With a doctorate in analytical chemistry from *Sofia University* (Bulgaria), Dr. Petrov joined Brooks Rand Labs in 2009 after completing his post-doctoral work on the identification and quantification of toxic metals and organometallic compounds at *Trent University* (Canada). Already published in several prestigious scientific journals, Dr. Petrov specializes in the research and development of cutting-edge analytical methods for the characterization and speciation of arsenic, chromium, lead, and selenium in highly complex matrices such as industrial wastewaters.

Dr. Petrov will contribute significantly to our efforts to develop among the most sophisticated metals speciation services available and will be presenting the results of some of his research at several major environmental conferences during the course of the year, including the 2010 *National Environmental Monitoring Conference* (NEMC) in Washington, DC and the 2010 *Society of Environmental Toxicology and Chemistry* (SETAC) conference in Portland, OR.

BROOKS RAND LABS

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About Brooks Rand Labs

Specializing in superior quality trace metals analytical services, Brooks Rand Labs focuses on metals speciation, trace level detection limits, and the analysis of complex matrices.

Experience & Expertise

Since 1982, Brooks Rand Labs has specialized in providing the highest quality trace metals analytical services and instrumentation. Low detection limits, outstanding data quality, and unparalleled customer service have established Brooks Rand Labs as the premier specialty metals analytical laboratory services provider.

As experts in the determination and characterization of trace metals in complex matrices, we have the capabilities to meet even the most challenging project requirements. Ultra-clean, pre-tested sampling equipment delivered directly, fast turn-around-time options, and custom reporting packages at competitive prices ensure that our clients receive the quality data they require to make critical decisions.

Ultra-low Detection and Reporting Limits

Brooks Rand Labs consistently strives to achieve detection and reporting limits that are among the lowest commercially available. Performance based evaluations of laboratory techniques ensure the most accurate and precise measurements at even the lowest concentrations. Ultra-clean facilities, laboratory equipment, and reagents, custom designed state-of-the-art instrumentation, and constantly improving methods allow Brooks Rand Labs to provide meaningful metals concentrations data in even the most challenging matrices.

Outstanding Data Quality

As an ultra-low level trace metals analytical laboratory, Brooks Rand Labs appreciates how important high quality data is for our clients. All our data is subjected to a rigorous multi-level review process to ensure only the most credible and scientifically defensible data is provided to our clients

The accuracy and precision of our data are constantly proven by internal and client-requested laboratory audits; consequently, Brooks Rand Labs is proudly NELAP accredited through the State of Florida Dept. of Health and certified in many additional states.

Unparalleled Customer Service

The project management team at Brooks Rand Labs provides clients with an unparalleled level of support from initial project planning, to data validation and interpretation, and project follow-up. They review quality assurance and sampling plans, advise on sampling procedures, and produce custom reporting packages that are superior to other analytical laboratories.