Superior Selenium Data by ICP-DRC-MS

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Selenium is only the seventieth most abundant element in the earth's crust and occurs mostly in low concentrations except as a byproduct of anthropogenic activity. Mining and irrigation agricultural practices that disturb seleniferous geological formations, coal-fired electricity generation, and petroleum refining processes can cause elevated concentrations of selenium to be mobilized into aquatic ecosystems.

While selenium is an essential micro-nutrient, research has shown that the thresholds for selenium-induced reproductive toxicosis among oviparous vertebrates, such as in fish and waterfowl, can be less than one order of magnitude greater than nutritional requirements. Well documented examples of the previously mentioned anthropogenic activities have repeatedly led to episodes of widespread wildlife poisoning; consequently, selenium contamination is increasingly recognized as an environmental concern.

Despite this growing awareness, few appreciate how difficult it can be to acquire accurate data for selenium concentrations, especially when the smallest difference can mean the distinction between a healthy ecosystem and one at risk.

Analysis by ICP-MS is widely recognized as one of the most advanced techniques for the determination of trace metals concentrations; however, selenium is also known to be particularly prone to mass spectral interferences. The plasma gas (argon) and constituents of the sample matrix (calcium, carbon, chloride, sulfur, etc.) can easily combine to form polyatomic ions with the same mass-to-charge ratios as the various isotopes of selenium, resulting in false-positives and elevated detection limits.

Example Interferences

Isotope	Abundance	Interferences
^{74}Se	0.87%	$^{37}Cl^{37}Cl^{+}$, $^{36}Ar^{38}Ar^{+}$
^{76}Se	9.02%	$^{40}Ar^{36}Ar+$, $^{38}Ar_2^{+}$
^{77}Se	7.58%	$^{40}Ar^{37}Cl^{+}$
^{78}Se	23.52%	$^{40}Ar^{38}Ar^{+}$, $^{38}Ar^{40}Ca^{+}$
^{80}Se	49.82%	$^{40}Ar_2^{+}$, $^{32}S^{16}O_3^{+}$
^{82}Se	9.19%	$^{12}C^{35}Cl_2^{+}$, $^{34}S^{16}O_3^{+}$

Without a technique to overcome these problems, critical decisions might be made based on inaccurate data. At Brooks Rand Labs, we employ ICP-MS equipped with dynamic reaction cell (DRC) technology to overcome mass spectral interferences. With ICP-DRC-MS, a highly reactive gas is introduced to produce gas-phase chemical reactions that breakdown polyatomic ions into neutral elemental species, nearly eliminating potential spectral interferences.

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Forrest Dierberg, Ph.D.
Vice President and Laboratory Director
DB Environmental, Inc.

As just one demonstration of the effectiveness of ICP-DRC-MS, the recoveries of several common biota certified reference materials (CRM) consecutively analyzed by both techniques are shown in the adjacent table. The false-positives that occur due to polyatomic interferences when analyzed by standard ICP-MS analyses are largely eliminated when analyzed by ICP-DRC-MS, resulting in far more accurate data.

Example Recoveries

CRM	ICP-MS	ICP-DRC-MS
TORT-2	127%	98%
DORM-3	137%	104%
SRM-2977	151%	104%

The method detection limits achievable by our NELAP and DoD ELAP accredited modification of EPA Method 1638 using ICP-DRC-MS are among the lowest commercially available, resulting in highly accurate and precise data for selenium concentrations in even the most complex matrices.

Method Detection Limits

water	0.015 µg/L
biota	0.02 mg/kg
sediment	0.16 mg/kg

The sample collection, preservation, and handling requirements for EPA Method 1638 are very specific in order to prevent inadvertent contamination, and consultation with one of our representatives is highly recommended prior to beginning a project. To learn more about our methods and how they can assist in your environmental remediation, monitoring, or regulated discharge projects, contact us today.