

Strontium, atomic absorption spectrometric, direct

Parameters and Codes:

Strontium, dissolved, I-1800-85 ($\mu\text{g/L}$ as Sr): 01080

Strontium, total recoverable, I-3800-85 ($\mu\text{g/L}$ as Sr): 01082

Strontium, suspended recoverable, I-7800-85 ($\mu\text{g/L}$ as Sr): 01081

Strontium, recoverable-from-bottom-material, dry wt, I-5800-85 ($\mu\text{g/g}$ as Sr): 01083

1. Application

1.1 This method may be used to analyze water, brines, and water-suspended sediment containing from 10 to 5000 $\mu\text{g/L}$ of strontium. Samples containing more than 5,000 $\mu\text{g/L}$ need to be diluted.

1.2 Suspended recoverable strontium is calculated by subtracting dissolved strontium from total recoverable strontium.

1.3 This method may be used to analyze bottom material containing at least 1.0 $\mu\text{g/g}$ of strontium. If the sample solution contains more than 5,000 $\mu\text{g/L}$ of strontium, it must be diluted.

1.4 Total recoverable strontium in water-suspended sediment needs to undergo preliminary digestion-solubilization by method I-3485, and recoverable strontium from bottom material needs to undergo preliminary digestion-solubilization by method I-5485 before being determined.

1.5 Samples containing more than 2,500 mg/L of total solutes need first to be diluted. If the strontium concentration in the diluted sample is below detection, the undiluted sample needs to be analyzed by the standard-addition method.

2. Summary of method

2.1 Strontium is determined by atomic absorption spectrometry. Lanthanum chloride and excess potassium chloride are added to mask interferences and control ionization of strontium in the flame (Fishman and Downs, 1966).

2.2 This procedure may be automated by the addition of a sampler, a proportioning pump, and a strip-chart recorder or a printer or both (fig. 1).

3. Interferences

3.1 Sodium and potassium decrease the strontium ionization in the flame. To control the ionization, 1,000 mg/L of potassium are added to both standards and samples.

3.2 Aluminum, phosphate, and silica interfere but are masked by the addition of lanthanum.

3.3 Nitrate interferes, but in the presence of lanthanum chloride-potassium chloride solution at least 2,000 mg/L can be tolerated. The addition of nitric acid in the field to preserve samples causes no problem.

3.4 Low strontium values result even in the presence of potassium and lanthanum if the dissolved-solids concentration exceeds 2,500 mg/L. For this reason, brines and highly mineralized waters must either be diluted or analyzed by the standard-addition method. For the standard-addition method, the dissolved solids content of the samples must be reduced to less than 20,000 mg/L.

4. Apparatus

4.1 *Atomic absorption spectrometer* equipped with electronic digital readout and automatic zero and concentration controls.

4.2 Refer to the manufacturer's manual to optimize instrument for the following:

Grating -----	Visible
Wavelength -----	460.7 nm
Source (hollow-cathode lamp) ---	Strontium
Oxidant -----	Air
Fuel -----	Acetylene
Type of flame -----	Slightly reducing

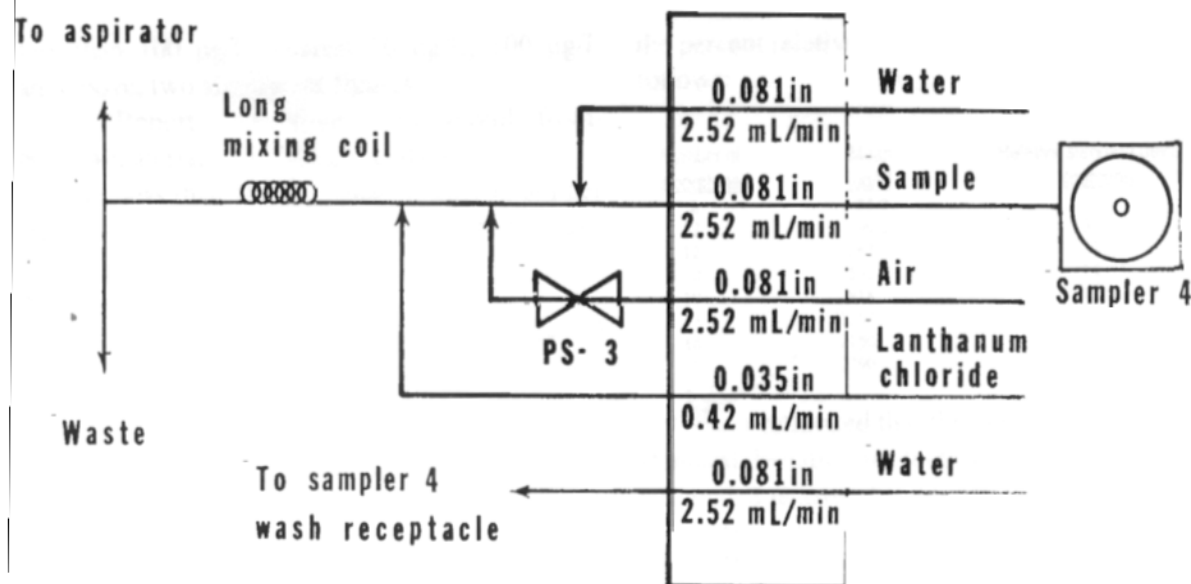


Figure 1. - Strontium manifold

4.3 The 100-mm (4-in.), single-slot burner allows a working range of 10 to 5,000 $\mu\text{g/L}$. Different burners may be used according to manufacturers' instructions.

5. Reagents

5.1 *Lanthanum chloride-potassium chloride solution*: Dissolve 117.3 g La_2O_3 in a minimum amount of dilute HCl. Add 19.1 g KCl, and dilute to 1,000 mL with demineralized water.

5.2 *Strontium standard solution*, 1.00 mL = 100 μg Sr: Dissolve 0.1684 g SrCO_3 in a minimum amount of dilute HCl, and dilute to 1,000 mL.

5.3 *Strontium working standards*: Prepare a blank and a series of at least six working standards containing from 10 to 5,000 $\mu\text{g/L}$ of Sr by appropriate dilutions of strontium standard solution. Add 1.0 mL of $\text{LaCl}_3\text{-KCl}$ solution to each 10 mL of working standards prepared. For example, to 500 mL of a working standard, add 50 mL $\text{LaCl}_3\text{-KCl}$ solution.

6. Procedure

6.1 Add 1.0 mL $\text{LaCl}_3\text{-KCl}$ solution to 10.0 mL of sample solution.

6.2 Aspirate the blank (10 mL demineralized water plus 1.0 mL $\text{LaCl}_3\text{-KCl}$ solution) to set the automatic zero control. Use the automatic concentration control to set concentrations of standards. Use at least six standards. Calibrate

the instrument each time a set of samples is analyzed and check calibration at reasonable intervals.

7. Calculations

7.1 Determine the micrograms per liter of dissolved or total recoverable strontium in each sample from the digital display or printer while aspirating each sample. Dilute those samples containing strontium concentrations that exceed the working range of the method and multiply by the proper dilution factors.

7.2 To determine micrograms per liter of suspended recoverable strontium, subtract dissolved-strontium concentration from total-recoverable-strontium concentration.

7.3 To determine micrograms per gram of strontium in bottom-material samples, first determine the micrograms per liter of strontium as in paragraph 7.1; then

$$\text{Sr } (\mu\text{g/g}) = \frac{\mu\text{g/L Sr} \times \frac{\text{mL of original digest}}{1000}}{\text{wt of sample (g)}}$$

8. Report

8.1 Report strontium, dissolved (01080), total-recoverable (01082), and suspended-recoverable (01081), concentrations as follows:

less than 100 µg/L, nearest 10 µg/L; 100 µg/L and above, two significant figures.

8.2 Report strontium, recoverable-from-bottom-material (01083), concentrations as follows: less than 10 µg/g, nearest microgram per gram; 10 µg/g and above, two significant figures.

9. Precision

9.1 Precision for dissolved strontium for 39 samples within the range of 55 to 2790 µg/L may be expressed as follows:

$$S_T = 0.119X + 12.886$$

where

S_T = overall precision, micrograms per liter, and

X = concentration strontium, micrograms per liter.

The correlation coefficient is 0.7322.

9.2 Precision for dissolved strontium for eight of the 39 samples expressed in terms of

the percent relative standard deviation is as follows:

<u>Number of laboratories</u>	<u>Mean (µg/L)</u>	<u>Relative standard deviation (percent)</u>
8	55.0	22
12	99.2	30
12	583	32
10	592	14
19	818	12
13	1260	24
10	2150	25
9	2790	5

9.3 It is estimated that the percent relative standard deviation for total recoverable and suspended recoverable strontium and for recoverable strontium in bottom material will be greater than that reported for dissolved strontium.

Reference

Fishman, M. J., and Downs, S. C., 1966, Methods for analysis of selected metals in water by atomic absorption: U.S. Geological Survey Water-Supply Paper 1540-C, p. 41-3.