

Trace Elements

in German Standard Cements 2001

Verein Deutscher
Zementwerke e.V.



Trace Elements in Cement

All input materials used in cement and concrete manufacture contain main and secondary constituents as well as trace elements. Between them, main and secondary constituents account for more than 99 % by mass. The corresponding trace element contents in cement and concrete are determined by the respective quantities of input materials and their content of trace elements. Depending on the deposits of the raw materials used, their trace element contents may differ substantially. The trace element contents of concrete are comparable to those found in natural rock.

The rate of release of trace elements from mortar and concrete is low. Investigations corroborate that they are permanently bound in the cement paste matrix. Furthermore, dense-structure concrete guarantees high resistance to diffusion, which additionally counteracts release.

Investigations of mortar and concrete test pieces verify that concentrations in eluates lie considerably below the values laid down by the Drinking Water Ordinance, for example. Storage under different conditions, some of which were extreme, did not lead to release of environmentally relevant proportions, not even when the test pieces were crushed and comminuted prior to the leaching test.

The following pages feature the results of extensive investigations on the trace element contents of cement performed on more than 400 spot samples taken for the quality surveillance of German standard cements in 2001. Table 1 shows the results of an evaluation.

In some of the Figures the determination limit was marked as a grey area to facilitate assessment. The concentration values above this area can be evaluated quantitatively.

The analyses have shown that routine analyses are liable to furnish incorrect results because of the great variety of potential sources of errors in trace element analysis. To obtain the measurement results (repeated tests) given here, the cements were subjected to complete decomposition by treatment in a mixture of nitric and hydrofluoric acid in a microwave oven. The elements were subsequently analysed by atomic absorption spectrometry (AAS) using inductively coupled plasma mass spectrometry (ICP-MS). In this process, mercury was determined using a flow-injection system based on the cold vapour AAS technique. All the other AAS determinations were performed using the graphite furnace and flame AAS techniques, respectively.

| Trace element | Average [µg/g] |
|---------------|----------------|
| Arsenic | 7.0 |
| Beryllium | 1.3 |
| Cadmium | 0.4 |
| Cobalt | 8.7 |
| Chromium | 41 |
| Copper | 31 |
| Mercury | 0.06 |
| Manganese | 759 |
| Nickel | 23 |
| Lead | 17 |
| Antimony | 2.9 |
| Selenium | n. d. |
| Tellurium | n. d. |
| Thallium | 0.4 |
| Vanadium | 50 |
| Zinc | 192 |
| Tin | 3.6 |

Table 1: Trace elements in standard cements (415 samples; n.d.: not determinable)

Note: For averaging, half the value of the determination limit was put in for the values below the determination limit.

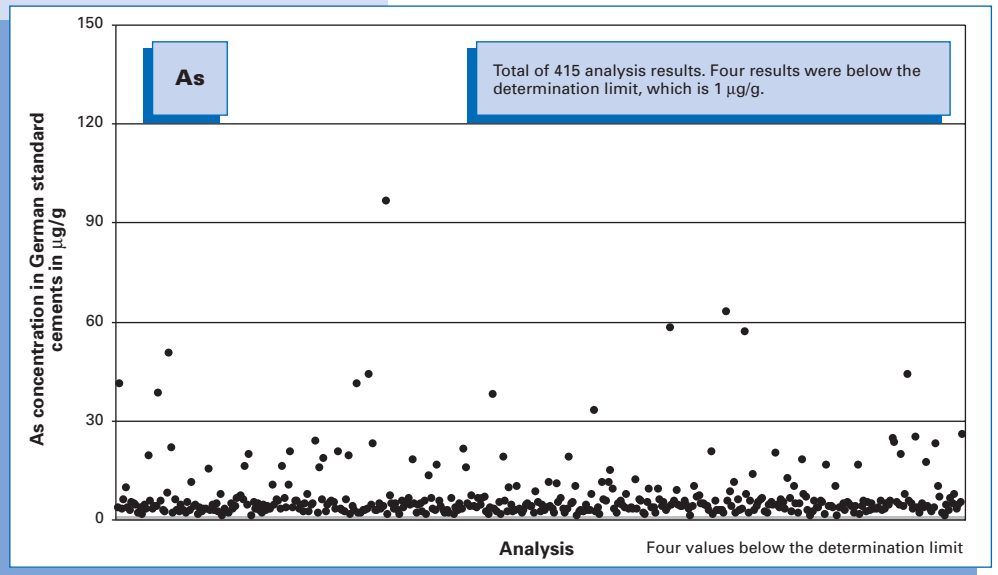


Fig. 1: Arsenic in standard cements

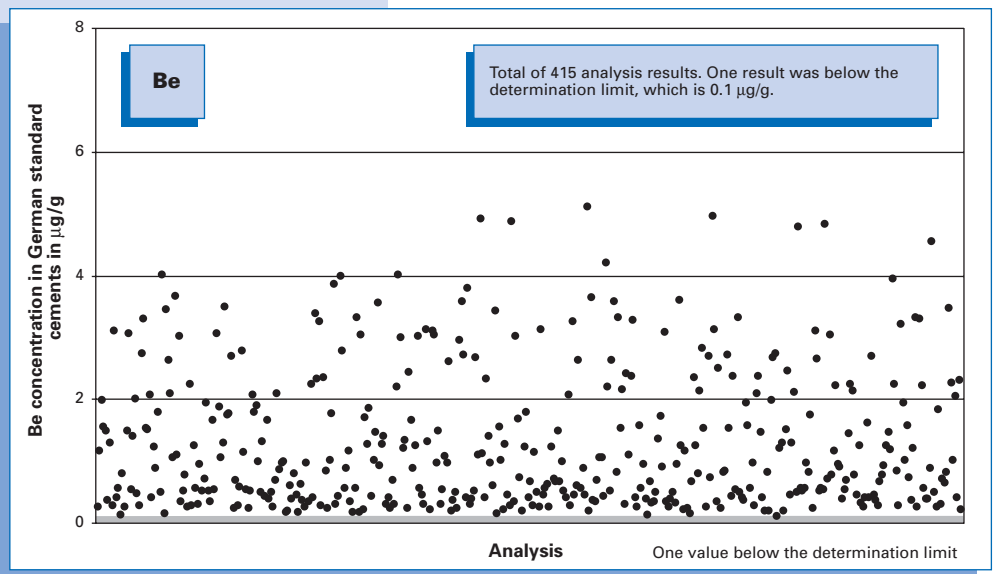


Fig. 2: Beryllium in standard cements

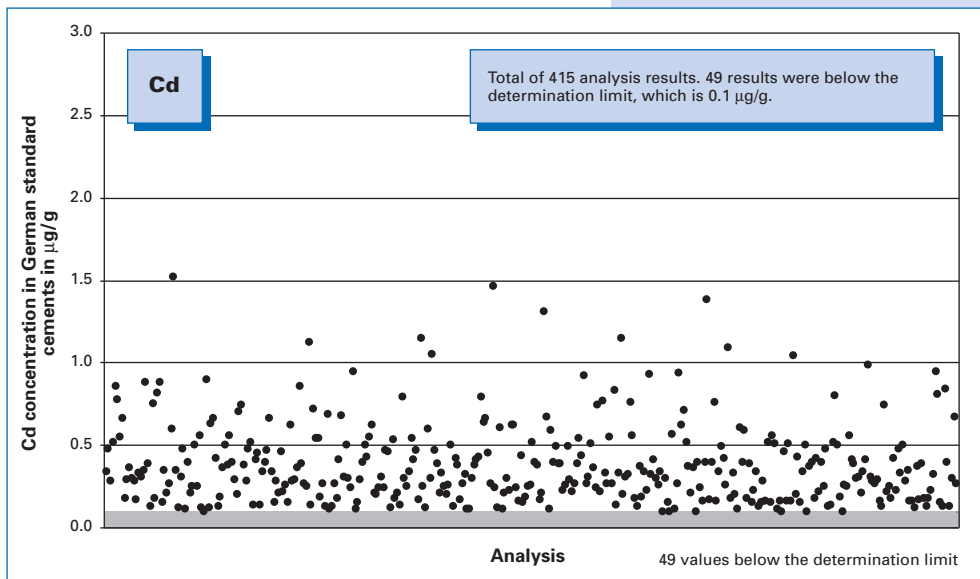


Fig. 3: Cadmium in standard cements

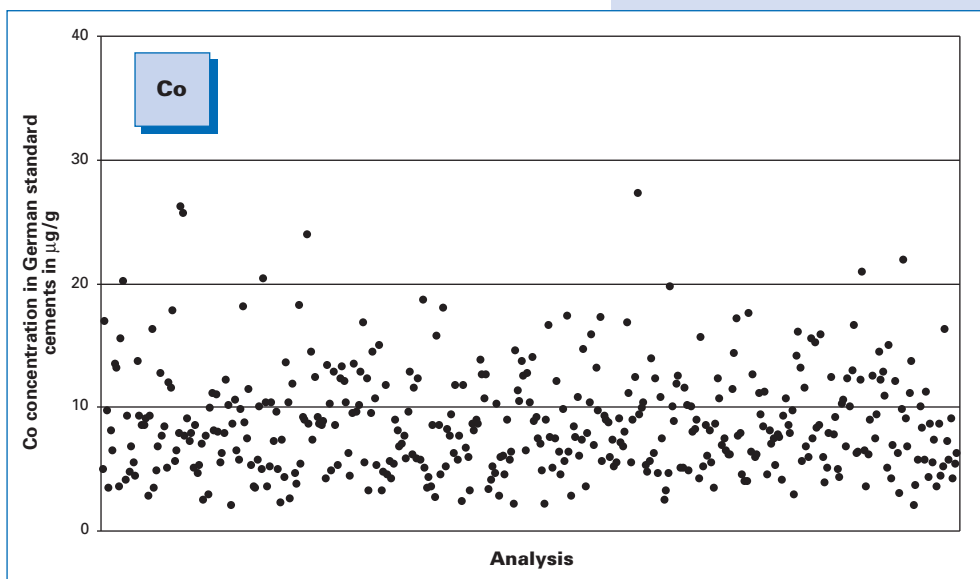


Fig. 4: Cobalt in standard cements

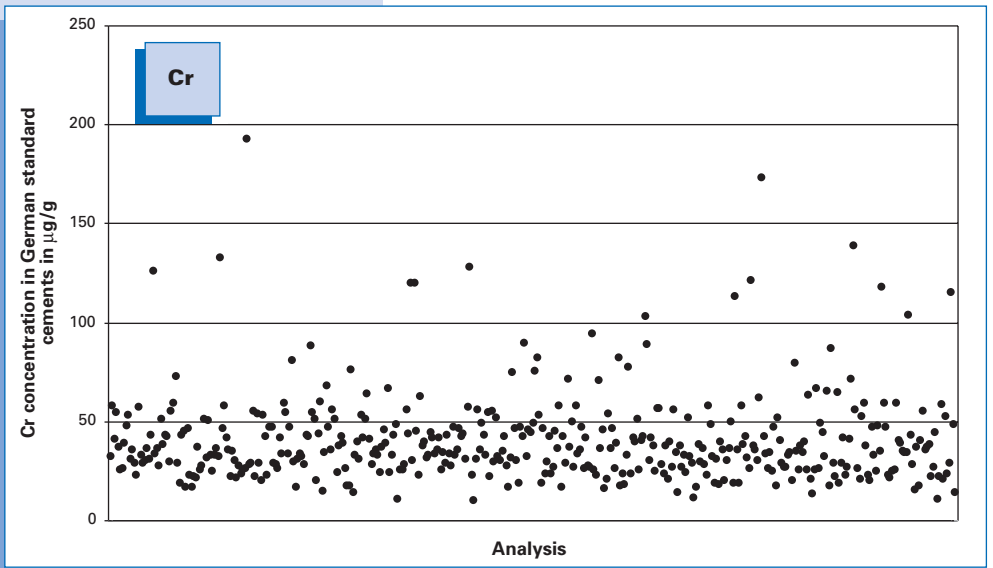


Fig. 5: Chromium in standard cements

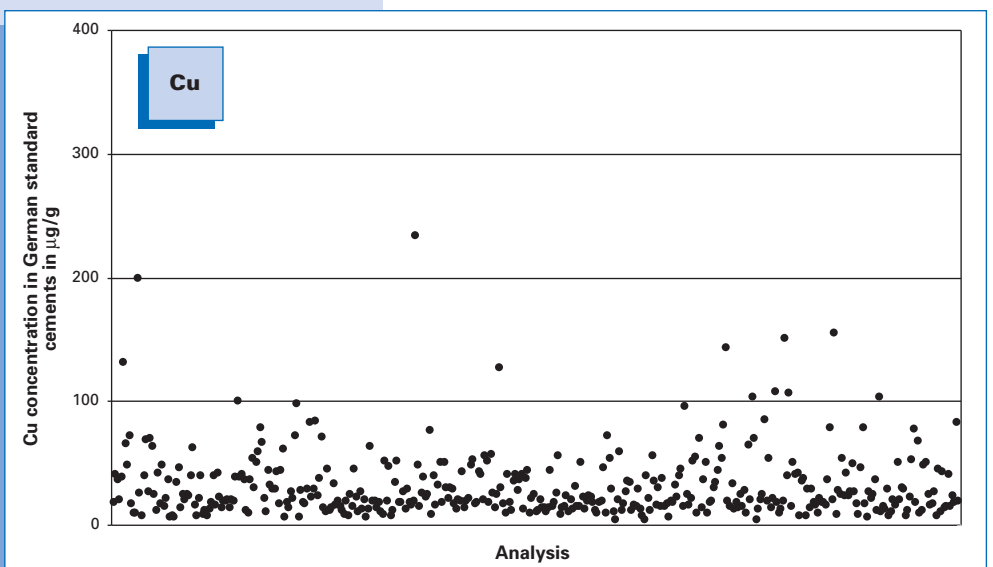


Fig. 6: Copper in standard cements

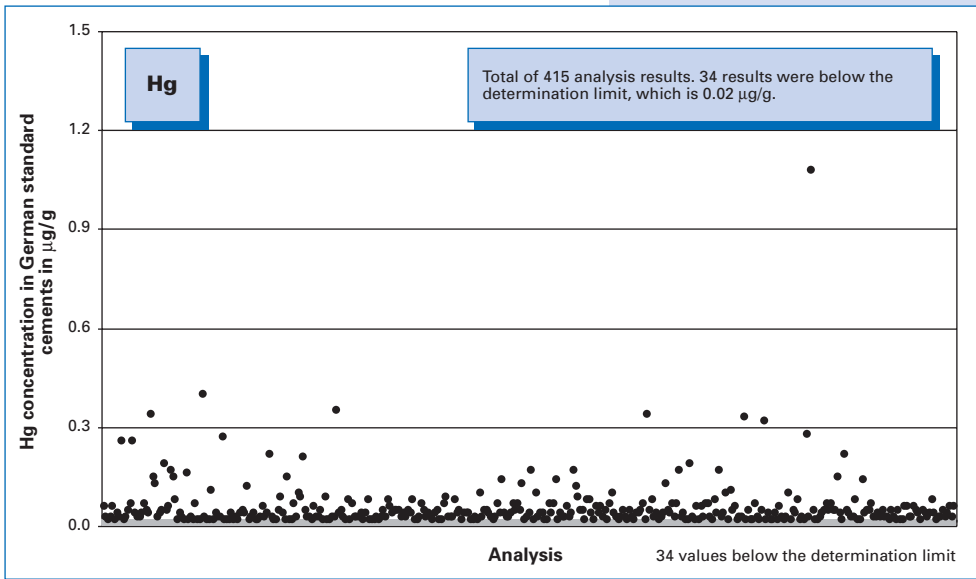


Fig. 7: Mercury in standard cements

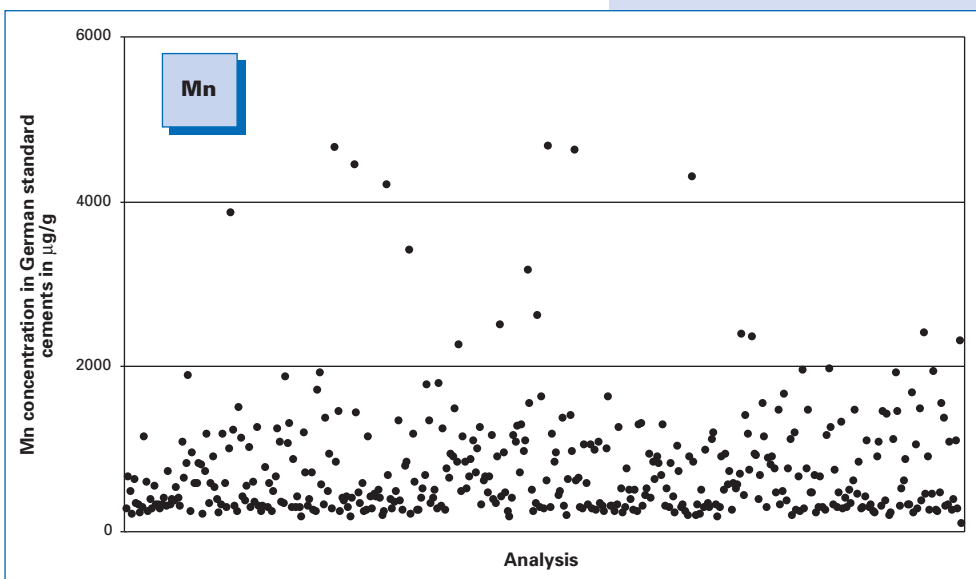


Fig. 8: Manganese in standard cements

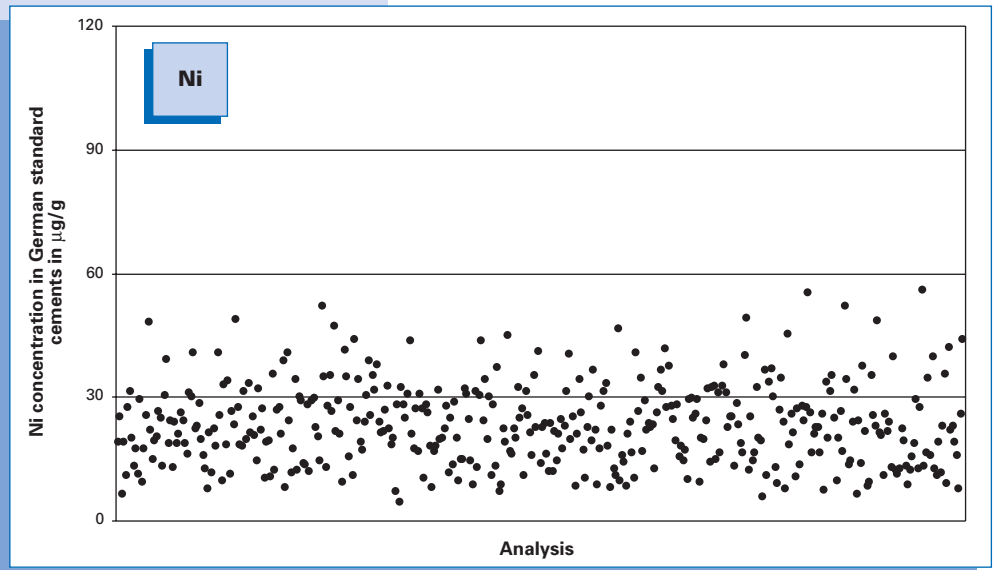


Fig. 9: Nickel in standard cements

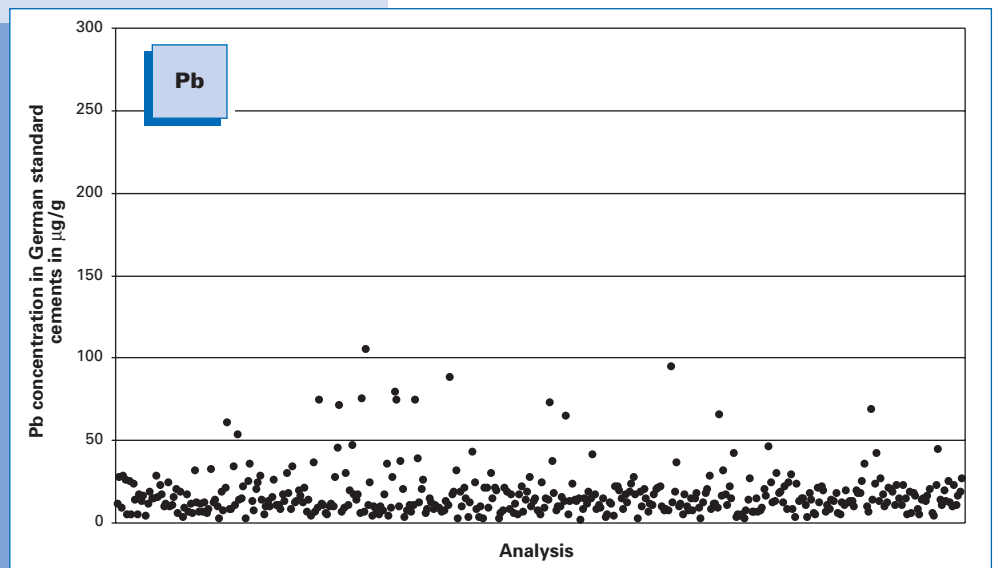


Fig. 10: Lead in standard cements

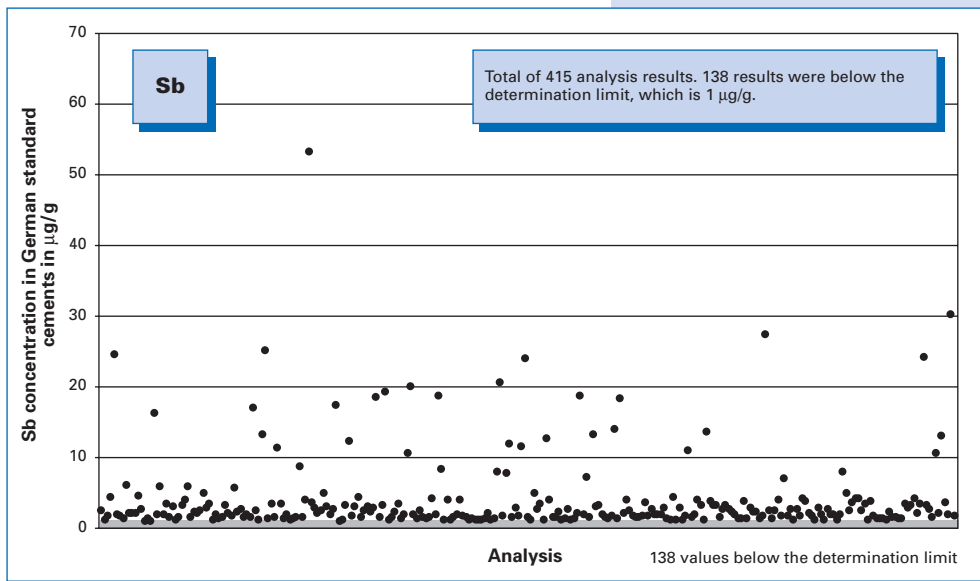


Fig. 11: Antimony in standard cements

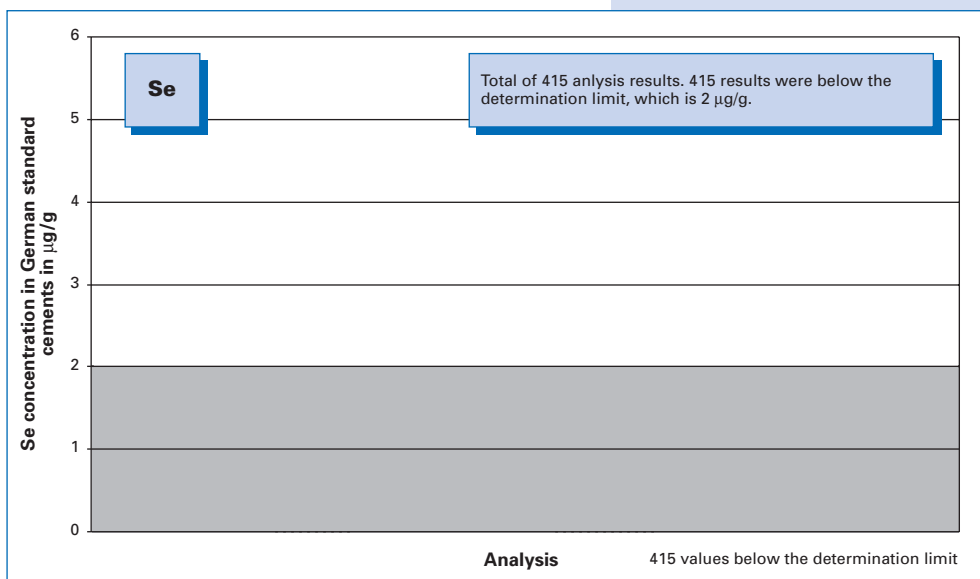


Fig. 12: Selenium in standard cements

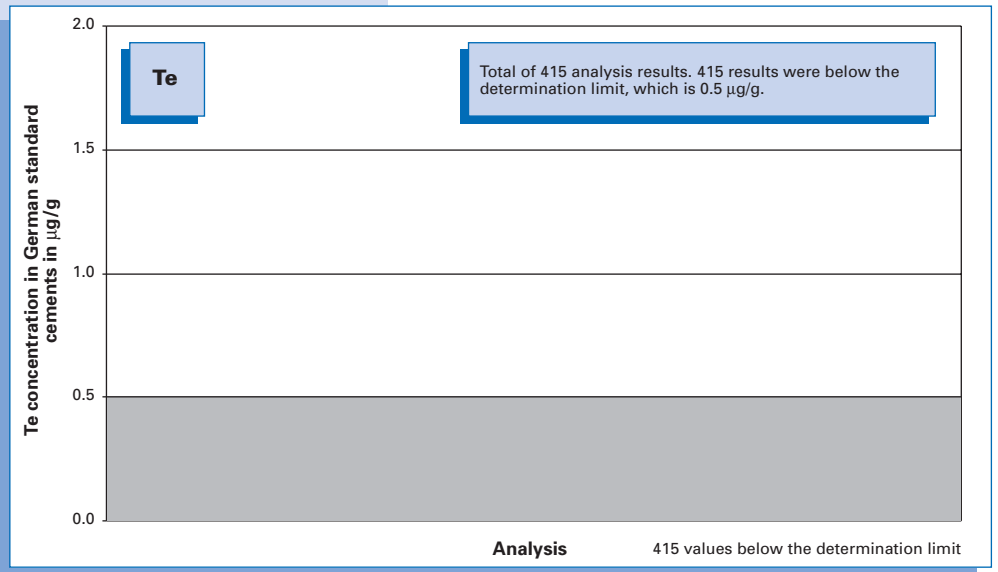


Fig. 13: Tellurium in standard cements

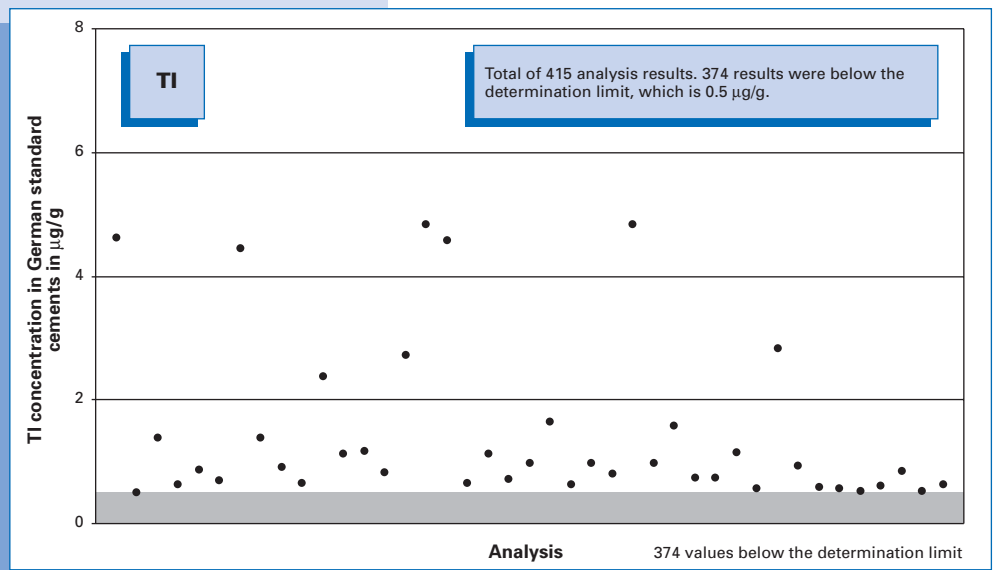


Fig. 14: Thallium in standard cements

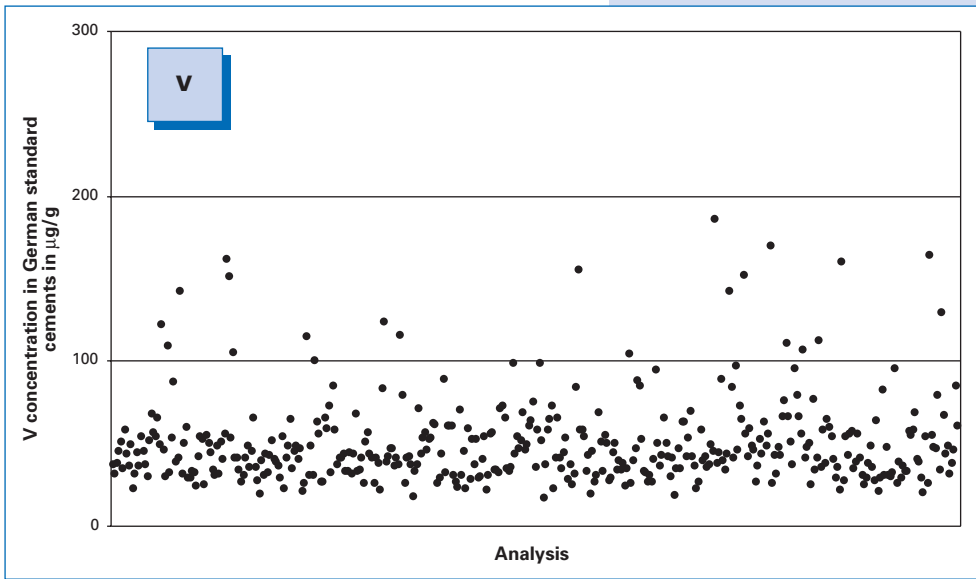


Fig. 15: Vanadium in standard cements

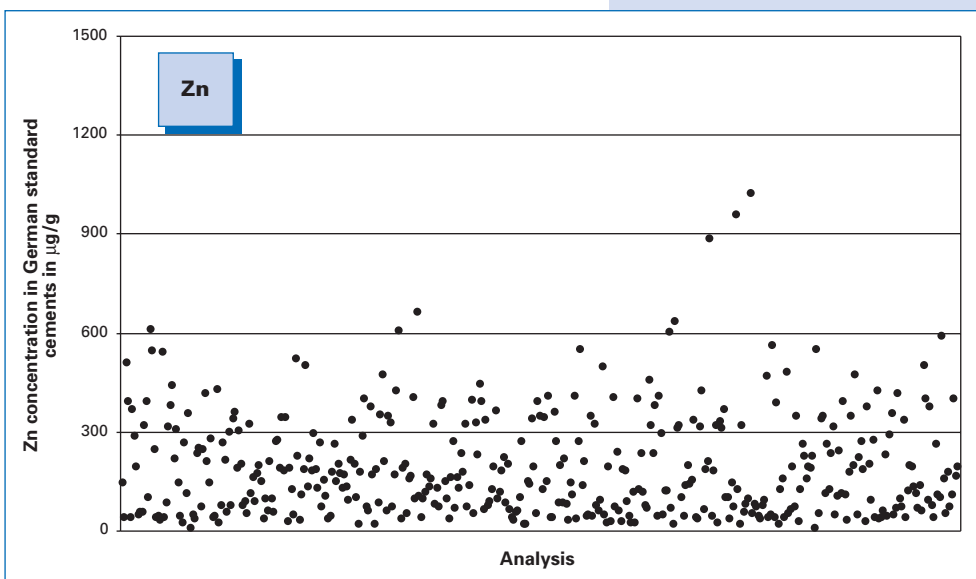


Fig. 16: Zinc in standard cements

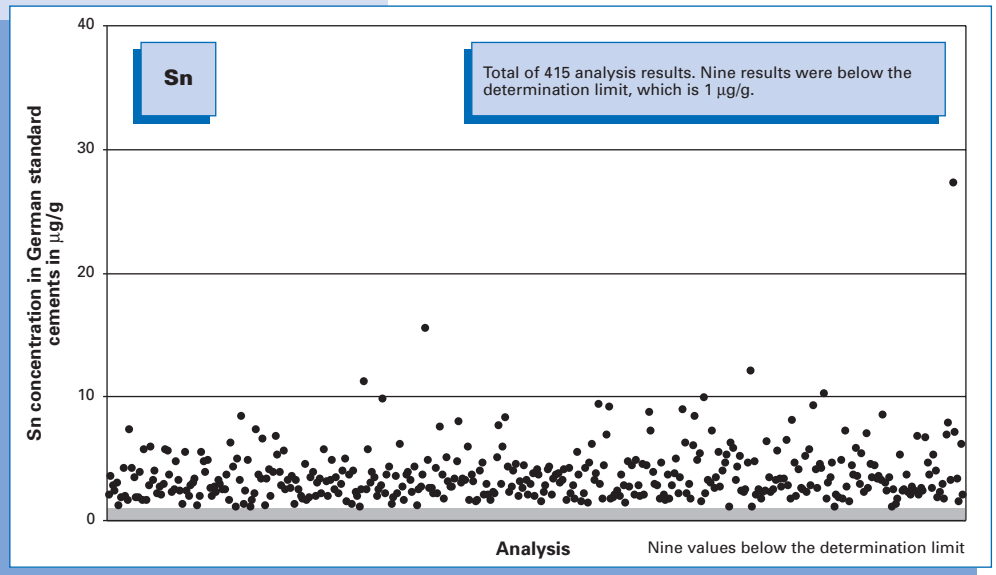


Fig. 17: Tin in standard cements

Impressum

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