SAFETY - RELATED ASPECTS DUE TO ORGANIC AND INORGANIC WASTE CONSTITUENTS

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ABSTRACT

To demonstrate the safety of a geological repository in the post-closure phase possible releases of radionuclides as well as organic and inorganic substances via the water path are to be investigated. In the appendix to the ordinance on groundwater protection of March 18, 1997, those families and groups of substances are listed which may cause a harmful pollution of groundwater or a detrimental change of its characteristics. Within the licensing procedure for the Konrad repository project it was shown that the respective organic and inorganic substances listed in this appendix as well as in further relevant documents may not reach or may reach the groundwater in a quantity so small as to obviate the danger of a deterioration of the groundwater.

INTRODUCTION

The protection of man and environment is the most important principle with regard to radioactive waste disposal. This fundamental principle is reflected in the licensing prerequisites for a repository. Factual prerequisites for the construction and operation of such a facility are, therefore, that the population will not be harmed. Since in Germany it is intended to dispose of radioactive waste in deep geological formations, possible releases via the water path must be investigated and assessed with regard to the safety of a disposal mine during the post-closure phase, i. e. the radiological long-term effects (radionuclide-specific radiation exposures) as well as possible pollution of near-surface groundwater by organic and anorganic substances. The latter will particularly take into account the principle of concern of section 34 "Reinhaltung" (Keeping Pure) of the Act on the Order of Water Resources Management (Water Resources Management Act - Wasserhaushaltsgesetz, WHG).

LEGAL REGULATIONS RELATING TO WATER

According to § 34 (2) WHG, substances may only be stored or deposited in such a way that a harmful pollution of the groundwater or another detrimental modification of its characteristics is not to be feared [1]. This principle of concern is put in more concrete terms through the Council Directive on the implementation of the Guideline 80/68/EEC of the Council of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (Grundwasserverordnung - Groundwater Ordinance) of 18 March 1997 [2].

With the Groundwater Ordinance, the above-mentioned Council Directive of the European Community in the field of water resources management [3] has been implemented by law. This ordinance mainly serves - in the field of legal regulations relating to water - the clarification or interpretation of the skeleton regulations of the Water Resources Management Law about the protection of groundwater [4]. The provisions mentioned here are clarified and interpreted in a legally binding way for the effective implementation of the CEC Council Directive on groundwater [3], particularly in sections 3 and 4 of the Groundwater Ordinance [2]. This ordinance does not constitutively determine particular duties of approval, but states more precisely existing duties of approval or licensing because of the Water Resources Management Law (e. g. according to sections 3 and 34 WHG).

In the Appendices (here: Lists I and II) of the Groundwater Ordinance, those families and groups of substances are qualitatively mentioned which may lead to a harmful pollution of the groundwater or to another detrimental modification of its characteristics (Tables 1 and 2). Regarding the safety of a repository during the post-closure phase, a possible apprehension with regard to this must, therefore, be investigated and evaluated; this presupposes sufficiently detailed data on the constituents of the radioactive waste packages intended for disposal.

The investigation and evaluation of a possible groundwater pollution by certain dangerous substances was performed within the framework of the licensing procedure for the Konrad mine as a repository for radioactive waste with negligible heat generation. The results of this investigation serve as the basis for the requisite permission under water law according to section 3 (2) no. 2 WHG and section 4 (2) no. 2 NWG [5]. Taking these investigations as an example, procedures and selected results of such an investigation of concern shall be shown in the following.

GEOLOGY AND HYDROGEOLOGY

The abandoned Konrad iron ore mine in the Federal State of Lower Saxony has been investigated for the emplacement of all types of solid or solidified low and intermediate level radioactive waste being short-lived and long-lived, respectively (radioactive waste with negligible heat generation). The Konrad mine is located in the south of a large iron ore formation. This sediment was deposited about 150 million years ago during the Upper Jurassic (Malm). The sedimentary oolithic iron ore stratigraphically forms part of the Middle Coral Oolith. The iron ore horizon has a maximum dip of 22 degrees in a westerly direction. The overlying Cretaceous strata mainly consist of clayish rock and completely cover the iron ore sediment by a transgression. The actual geological barrier to the near-surface groundwater is built up by the Lower Cretaceous clay layers overlying the trough-shaped Jurassic strata over a wide area. The overburden barrier increases in thickness from east to west-corresponding to the inclination of the repository formation. The overlapping by the deeper Lower Cretaceous is not thinner than 170 m at any point above the mine. To the west, it increases to about 270 m, and to the north to nearly 400 m. The remaining overlapping of the mine openings by the marl is thinnest in the east - about 210 m, increasing to a maximum of 300 m towards the west. The sand horizon at the base of the Albian (Hils sandstone) only occurs above the southern part of the mine openings in thicknesses of a maximum of about 5 m . The good quality of the Upper Cretaceous barrier was proved by means of a variety of laboratory analyses of drilling cores covering petrography, geochemistry, porosity, permeability, absorption and rock strength.

The hydrogeological situation is characterised by a pronounced stockwork structure. The ground water near the surface, locally influenced by human use is mostly found in Quaternary deposits and is hydraulically connected to local water courses. Below a depth of about 100 m, the ground water contains considerable amounts of solutes. The deeper ground water levels consist of individual aquiferous strata, separated by claystone strata with minimum water-bearing properties. The system is bordered above and below by salt layers of the Middle Muschelkalk; the lateral hydraulic borders are formed by salt domes.

Based on prior experience with the low amount of already existing water in the mine openings an uncontrolled inflow of water during the operational period can be excluded. In the post-closure phase, however, the remaining voids will gradually fill up with subterranean waters. The original pressure conditions will not widely be restored for over 2,000 years. Only then the natural, very slow, regional subterranean water movement could start again. Parameter studies were used to calculate the movement of subterranean waters. Parameter variations were employed to investigate various connections of layers and influences of geological fault zones. It was seen that waterpaths leading from the mine openings would reach the biosphere at various places, depending on the permeability coefficients for Lower Cretaceous.

ESTIMATION OF THE INVENTORY OF ORGANIC AND INORGANIC NON-RADIOAC-TIVE SUBSTANCES TO BE EXPECTED

Waste packages to be disposed of consist of a large number of organic and inorganic non-radioactive substances. To be able to investigate and evaluate a possible pollution of the groundwater by these substances, data on the material composition of those waste packages must be considered, the final disposal of which in the Konrad mine is intended.

The basic data required was mainly determined within the framework of an inquiry into the respective inventories at the waste generators. Additionally, comprehensive bibliographical evaluations were performed, taking into account all radioactive waste with negligible heat generation which - according to the present state of knowledge - may be emplaced in the Konrad repository. When determining the basic data, it was, for reasons of transparency and explicitness, differentiated between such material components which are to be assigned to the actual radioactive waste, the immobilization material used and the waste containers and/or packagings. These single data was then combined in the total material inventory and accumulated.

The registration of the material components led to the following results:

- The portion of organic substances at the total mass of the waste packages to be disposed of (here: referring to a waste package volume of approx. 650,000 m^3) is at the end of the operational phase approx. $2.91 \cdot 10^4$ Mg (approx. 1.8%). This mass also includes organic chemotoxic substances.
- The portion of inorganic substances at the total mass of the waste packages to be disposed of (here: referring to a waste package volume of approx. 650,000 m^3) is at the end of the operational phase approx. $1.63 \cdot 10^6$ Mg (approx. 98.2%). This mass also includes inorganic chemotoxic substances.

The total mass of organic and inorganic substances included in the waste package volume of approx. 650,000 m^3 planned for disposal is thus $1.66 \cdot 10^6$ Mg.

To take into account the protection goal of section 34 (2) WHG, the examination of a possible pollution of the groundwater was not only limited to the substances given in Lists I and II of the Appendices to the Groundwater Ordinance, but, additionally, further substances were included in the investigation which have been limited in appropriate ordinances, regulations and recommendations to be consulted for this. Therefore, the evaluation of the above-mentioned inventories takes into account those organic and inorganic substances which are included in the waste package volume of approx. 650,000 m^3, and in particular in

- the Appendix to the Groundwater Ordinance, Lists I and II [2],
- the recommendations of the Federal State Working Group on Water (Länderarbeitsgemeinschaft Wasser) [6], including the drafts of the updated test values [7],
- the Drinking Water Ordinance (Trinkwasserverordnung) [8], and
- the standard of the German Company of Gas and Water (Deutscher Verein des Gas- und Wasserfaches e.V.) [9].

In addition, international recommendations [10] and investigations are referred to which were performed within the framework of the plausibility investigation on the chemotoxicity of radioactive waste with negligible heat generation [11, 12]. Furthermore, other documents are consulted which are linked with carcinogenic, mutagenic and teratogenic effects of organic and anorganic substances [13].

Following the evaluation of the basic data determined with regard to organic substances which have to be taken into account within the framework of the investigation and evaluation of a possible pollution of the groundwater, their accumulated mass is $4.08 \cdot 10^3$ Mg, i. e. approx. 13.8% of the total portion of organic substances of $2.91 \cdot 10^4$ Mg. Polystyrene, tensides, polyethylene, oil as well as oil residues and Na_2-oxalate have the largest portions of this mass. The corresponding evaluation for inorganic substances had led to an accumulated mass of $9.34 \cdot 10^5$ Mg, i. e. approx. 57.3% of the total portion of inorganic substances of $1.63 \cdot 10^6$ Mg. The five substances Fe, Ca, Al, Na and Mg contribute the largest portions to this mass; proportionally, they are included most frequently in the radioactive waste from research and development (Fe, Ca, Mg, Na, Al), the operation of nuclear power plants (Fe, Ca, Na, Mg) and reprocessing (Al).

MODEL CALCULATIONS ON THE POSSIBLE POLLUTION OF THE GROUNDWATER

Harmful substances can only be released from a repository into geological formations via the water path as means of transport. When the biosphere is reached, the harmful substances can primarily only be taken up by man via the ingestion pathway, in particular via drinking water. Against this background, a possible pollution of the groundwater has been examined and evaluated with the help of conservative model calculations. After having been dissolved in the deep water of the Konrad mine and diluted through dispersion and diffusion during transportation through the geosphere and in the Quaternary, the performed considerations are based on a comparison of concentrations, i. e. the concentrations of organic and inorganic waste package constituents are compared to limitations of concentrations for chemical elements and organic and/or inorganic compounds in the near-surface groundwater and/or drinking water. The following assumptions and/or marginal conditions apply:

- A waste package volume of approx. 650,000 m^3 disposed of is assumed. This volume was, in particular, also assumed in the safety assessment for the post-closure phase of the Konrad repository project.
- At the beginning of the post-closure phase, the total mass of this waste package volume is assumed as having entirely been dissolved in 10^6 m^3 of Konrad deep water (most unfavourable hypothetical initial situation). No credit is taken within the framework of this conservative approach of the dynamics of this procedure following the backfilling of the remaining voids with slowly entering deep water, which would be required first, and the gradual solution of the substances during simultaneous transportation. This neither considers the temperature dependency of the solubility of organic and inorganic substances.
- No credit is taken of the fact that through the large masses of concrete and cement in the repository (immobilization material, waste containers), the chemical environment will first be changed to the alkaline range (pH = 12 to pH = 14), in which the solubility of the substances might be reduced considerably. Neither are precipitation and flocculation reactions, which may lead to for the involved reaction partners in this chemical environment to clear decreases in concentration of the dissolved substances, not taken into consideration within the framework of this conservative model assumption. On the other hand, reactions which may lead to an increase in solubility due to the formations of easily soluble reaction products are not taken into account too.
- The following considerations are made as if the single substances have been dissolved in water alone. Interactions which must be assumed due to the actually existing multi-substance and/or multi-component system, including solubility increases or decreases possibly connected with them, are not taken into account within the framework of this conservative model assumption.
- As a rule, no retension through sorption processes at the rocks is assumed for the organic and inorganic substances with regard to their transport through the geosphere, i. e. no credit is taken within the framework of this conservative model assumption of this barrier effect of the layers of the emplacement horizon as well as the layers overlying and underlying the emplacement horizon (depth of the emplacement horizon: 800 m to 1,300 m).

  - The model assumptions particularly concentrate on the additional pollution of the water by organic and inorganic substances from the waste packages and do not consider that large masses of the same inorganic substances exist, for instance, in the sediments of the emplacement horizon.
  - For the comparison with the concentration limitations for organic and inorganic substances in the near-surface groundwater, particularly the recommendations of the Federal State Working Group on Water [6, 7] are taken as a basis as well as the Drinking Water Ordinance [8] and the DVGW standard [9].

In connection with these assumptions and marginal conditions, it has in particular to be pointed out that

- it is questionable because of the experimental investigations at the Konrad site carried out whether a convective substance transport of the deep water through the geosphere up to the area of the near-surface groundwater may be possible. The age of the Konrad deep water of at least 10^7 years, possibly even $1.5 \cdot 10^8$ years, corresponds to the age of the geological formation. These ages indicate groundwater movements in the range of less than 1 cm per 10^3 years up to stagnating formation water [14-16].
- the salinity of the deep water increases with depth. A transport of the water originating from the emplacement horizons to areas with waters with lower salt contents would, therefore, have to take place against the density gradient caused by the increase of salt concentration. Among other things, the measured density distribution indicates a diffusion-dominated vertical salt transport and, thus, stagnating deep water [17].
  - in the case of a transport via the water path, dissolved harmful substances cannot be faster than the pure water movement. Since according to the model calculations
    - on groundwater movement the shortest flow times for the characteristic migration paths are in the range of 330,000 years up to 38.8 million years,
    - on the assessment of long-term safety of the Konrad repository the conservatively assumed transport of the deep water up to the nearsurface groundwater thus lasts at least 300,000 years, a possible pollution of the water can be excluded, at least within the period of time mentioned last.

Against the background of all assumptions and marginal conditions on which this investigation and evaluation is based, it can, therefore, clearly be stated that this is an extraordinarily conservative, i. e. very secure model assumption.

INVESTIGATION AND EVALUATION OF A POSSIBLE POLLUTION OF THE NEAR-SURFACE GROUNDWATER

According to the above-mentioned considerations, it is assumed in the case of organic and inorganic substances that, at the beginning of the post-closure phase, they have entirely been dissolved in 10^6 m^3 deep water. Taking into account the expected masses of these substances, their theoretical concentration in the deep water can thus be determined. Starting from these concentration values and considering the solubility of the respective substances, their concentration in the near-surface groundwater is derived with the help of dilution factors [11]. The concentrations in the Quaternary groundwater determined in such a way are then compared, in particular, with test values of the recommendations of the Federal State Working Group on Water (Länderarbeitsgemeinschaft Wasser, LAWA) [6, 7]. These test values play an important role, since, as a rule, the suspicion of danger - and with this also the fear of a harmful pollution of the groundwater or another detrimental modification of its characteristics in the sense of section 34 (2) WHG - is considered dispelled [6].

The comparison of the concentration occurring for an organic or inorganic substance in the near-surface groundwater with the affiliated limitation was performed in such a way that each time the most restrictive value of [6, 7] was used. The conservative model assumptions performed according to this procedure, comprise a large number of organic and inorganic substances; this will be explained in detail with two examples.

Groundwater Ordinance, Appendix: List I, Serial Number 8

Within the framework of the above-mentioned inquiry into the respective inventories, the waste generators submitted data on the cyanides mentioned under the serial number 8 (Table 1), in the form of potassium and nickel cyanides (potassium and nickelhexaferrocyanides) with an accumulated mass of $2.74 \cdot 10^4$ kg in approx. 650,000 m^3 waste package volume. Based on this mass, the cyanide concentrations in the deep water and the near-surface groundwater were calculated and compared with the relevant test values and/or concentration limits (Table 3).

The following applies:

- Since potassium and nickelferrocyanide (potassium and nickelhexaferrocyanides) are very stable complex compounds, the limitation for cyanide with $5.0 \cdot 10^{-5}$ g/l was taken as a basis from the updated test values of the LAWA [7].
- The potassium-hexacyanoferrates (II) and (III) can both be dissolved in water [18]; their solubility is given with $9.0 \cdot 10^2$ g/l in [19]. According to [20], nickelferrocyanide (nickel-hexaferrocyanide) is difficult to dissolve and/or cannot be dissolved at all according to [19]. In the sense of the conservative procedure chosen here, the above-mentioned solubility is used for both complex compounds, i. e. for the soluble potassium ferrocyanide and the nickel ferrocyanide which is difficult to dissolve. This results in the fact that the calculated cyanide concentration is one order of magnitude below the concentration limit of the DVGW standard [9] (Table 3).
- A harmful pollution of the groundwater or another detrimental modification of its characteristics through potassium or nickel ferrocyanide (potassium and nickel-hexaferrocyanide) is, therefore, not to be feared.

Groundwater Ordinance, Appendix: List II, Serial Number 1

List II of the Appendix to the Groundwater Ordinance is given in Table 2. The serial number 1 mentions metalloids, metals and their compounds. Among those are the following inorganic toxic substances:

zinc
copper
nickel
chromium
lead
selenium
arsenic
antimony
molybdenum
titanium
tin
barium
beryllium
boron
uranium
vanadium
cobalt
thallium
tellurium
silver

Assuming the accumulated masses of these constituents in approx. 650,000 m^3 waste package volume, their concentrations in deep water and, following this, in near-surface groundwater were calculated. Essential results of these considerations are (excerpts given in Table 4):

- The comparison of the concentrations in near-surface groundwater with each relevant limitation shows immediately that the test values and/or concentration limits are fallen below, as a rule, by one to ten orders of magnitude. Taking into account the assumptions and marginal conditions made, it is, therefore, not to be feared that the respective substances contribute to a harmful pollution of the groundwater or another detrimental modification of its characteristics.

- With regard to silver, the concentration in the near-surface groundwater of $1.0 \cdot 10^{-5}$ g/l, which was estimated within the framework of this model assumption, corresponds with the concentration limit of the Drinking Water Ordinance [8, 21] as far as the figures go, but neither in this case there is need to be worried:
- Silver is not limited in the recommendations of the Federal State Working Group on Water; no test value is given in [6, 7].
- Since silver in the concentration range which is relevant to environment and drinking water does not represent a provable risk to man´s health [9, 21] and the current concentrations in natural water are with 1 to $3 \cdot 10^{-6}$ g/l clearly below the limit of $1.0 \cdot 10^{-5}$ g/l for drinking water [8, 21], the DVGW standard does without the determination of a normal requirement and a minimum requirement [9].
- With regard to the silver concentration in drinking water, it must also be taken into account that silver, silver chloride, sodium silver chloride complex and silver sulfate are permitted additives for drinking water purification [8, 21]. The limit after purification - including the contents prior to purification and of other purification stages - is $8.2 \cdot 10^{-5}$ g/l, i. e. it is eight times larger than the above-mentioned concentration for Ag of $1.0 \cdot 10^{-5}$ g/l.
- According to international recommendations of the World Health Organization, it is not considered necessary to give a standard (guideline) value for silver in drinking water [10].
  - In the model assumption, especially no barrier functions of the geological formations were appropriated for silver. In addition to this, it must be considered that the solubility of silver decreases with decreasing salt concentration.
- For titanium, test values and/or concentration limits are given neither in the LAWA [6, 7] recommendations nor in the Drinking Water Ordinance [9]. The harmlessness of the estimated drinking water concentration results from the following:
  - Ti is not among the inorganic chemotoxic elements and does not represent a risk [11, 22, 23].
  - The determined Ti concentration in the near-surface groundwater of $4.8 \cdot 10^{-8}$ g/l is one order of magnitude below the value of $1.0 \cdot 10^{-7}$ g/l, for which concentrations of harmful substances are considered non-relevant with regard to health.
  - There are no indications that titanium dioxide taken in or injected is accumulated in the body or that titanium is an essential element for man or animals [23]. The human body seems to have a high tolerance with regard to titanium. According to an indication in [23], man takes in 0.3 to 1 mg titanium per day according to Valentin and Schaller, excretes, however, the largest part of it. The body of adult persons contains approx. 15 mg titanium, mainly in the lung. Valentin and Schaller consider a monitoring of the titanium concentrations in the human body not necessary; the same applies to titanium dioxide which is the titanium compound mostly used by the industry.
  - According to international recommendations for the quality of drinking water [10], titanium is not among the health-damaging substances the concentration of which would have to be limited. Within the framework of an evaluation of inorganic substances which potentially damage health, Ti is classified there as "no action required".
  - In waste-specific documents too titanium is neither classified as "hazardous constituent" [24] nor mentioned or, respectively, limited in the assignment of waste for surface deposition [25].

CONCLUDING EVALUATION

The investigation and evaluation of a possible pollution of groundwater by organic and inorganic substances performed within the framework of the Konrad licensing procedure, was carried out with the help of model assumptions. It could be shown that under the assumptions and marginal conditions chosen here, the test values of the LAWA recommendations as well as the concentration limits of the Drinking Water Ordinance and/or the DVGW standard is partly fallen below, as a rule, by more than one order of magnitude. This does not only apply to the substances mentioned in the Appendices to the Groundwater Ordinance, Lists I and II, but, additionally, to further organic and inorganic substances which have been limited in relevant recommendations, ordinances and standards and which have been mentioned as well in the plausibility study on the chemotoxicity of radioactive waste with negligible heat generation and in analyses of the near-surface groundwater. With their consideration, the protection goal of section 34 (2) WHG is particularly taken into account.

Taking into consideration the chosen approach, to perform a conservative worst-case study, it must be assumed that in reality, much lower concentrations of the organic and inorganic substances investigated will occur in the near-surface groundwater. This underlines the very conservative character of the single results achieved. The complete result is, therefore, that, in particular, the test values of the recommendations of the Federal State Working Group on Water [6, 7] have not been exceeded and that, thus, the existence of danger can be excluded. According to the considerations and investigations performed, certain dangerous substances of the waste packages cannot reach the groundwater or can only reach it in such low concentrations that

- only anthropogenicly caused, low additional pollutions of the near-surface groundwater can be expected, and
- the future danger of a damage of the groundwater quality and/or a harmful pollution of the groundwater or another detrimental modification of its characteristics in the sense of section 34 (2) WHG need not be feared.

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Table 1 Groundwater Ordinance, Appendix: List I

LIST I OF FAMILIES AND GROUPS OF SUBSTANCES

List I contains the individual substances which belong to the families and groups of substances enumerated below, with the exception of those which are considered inappropriate to list I on the basis of a low risk of toxicity, persistance and bioaccumulation.

Such substances which regard to toxicity, persistance and bioaccumulation are appropriate to list II are to classed in list II.

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment.

2. Organophosphorus compounds.

3. Organotin compounds.

4. Substances which possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment.

5. Mercury and its compounds.

6. Cadmium and its compounds.

7. Mineral oils and hydrocarbons.

8. Cyanides.

Table 2 Groundwater Ordinance, Appendix: List II

LIST II OF FAMILIES AND GROUPS OF SUBSTANCES

List II contains the indiviual substances and the categories of substances belonging to the families and groups of substances listed below which could have a harmful effect on groundwater.

1. The following metalloids and metals and their compounds:
    1. Zinc
    2. Copper
    3. Nickel
    4. Chrome
    5. Lead
    6. Selenium
    7. Arsenic
    8. Antimony
    9. Molybdenum
    10. Titanium
    11. Tin
    12. Barium
    13. Beryllium
    14. Boron
    15. Uranium
    16. Vanadium
    17. Cobalt
    18. Thallium
    19. Tellurium
    20. Silver

2. Biocides and their derivatives not appearing in list I.

3. Substances which have a deleterious effect on the taste and/or odour of groundwater, and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption.

4. Toxic or persistent organic compounds of silicon, and substances which may cause the formation of such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances.

5. Inorganic compounds of phosphorus and elemental phosphorus.

6. Fluorides.

7. Ammonia and nitrites.

Table 3 Cyanide concentration in near-surface groundwater compared to respective concentration limits in drinking water

Inorganic Substance	**Concentration in Deep Water [g/l]**	**Solubility [g/l]**	**Concentration in Near-surface Groundwater [g/l]**	**Test Value/ Concentration Limit [g/l]**	**Ref.**
Cyanides	$2{,}7 \cdot 10^{-2}$	$2{,}7 \cdot 10^{2}$	$2{,}7 \cdot 10^{-6}$	$1{,}0 \cdot 10^{-5}$	[9]

Table 4 Concentration of inorganic substances in near-surface groundwater compared to respective test values in groundwater or concentration limits in drinking water

Inorganic Substances	**Concentration in Deep Water [g/l]**	**Solubility [g/l]**	**Concentration in Near-surface Groundwater [g/l]**	**Test Value/ Concentration Limit [g/l]**	**Ref.**
Ag	$1,0 \cdot 10^{-1}$	$1,1 \cdot 10^{-1}$	$1,0 \cdot 10^{-5}$	$1,0 \cdot 10^{-5}$	[8]
As	$3,3 \cdot 10^{-4}$	$7,5 \cdot 10^{-2}$	$3,3 \cdot 10^{-8}$	$5,0 \cdot 10^{-4}$	[9]
B	$8,4 \cdot 10^{-1}$	$6,3 \cdot 10^{-1}$	$8,4 \cdot 10^{-5}$	$1,0 \cdot 10^{-4}$	[6]
Ba	$7,7 \cdot 10^{-1}$	$2,2 \cdot 10^{-3}$	$2,2 \cdot 10^{-6}$	$3,0 \cdot 10^{-4}$	[7]
Be	$2,4 \cdot 10^{-5}$	$9,0 \cdot 10^{-2}$	$2,4 \cdot 10^{-9}$	$1,0 \cdot 10^{-7}$	
Mo	$1,6 \cdot 10^{-1}$	$4,8 \cdot 10^{-5}$	$4,8 \cdot 10^{-8}$	$5,0 \cdot 10^{-5}$	[7]
Se	$4,8 \cdot 10^{-5}$	$7,9 \cdot 10^{-1}$	$4,8 \cdot 10^{-9}$	$1,0 \cdot 10^{-6}$	[9]
Sn	$7,2 \cdot 10^{-2}$	$1,0 \cdot 10^{-2}$	$1,0 \cdot 10^{-5}$	$4,0 \cdot 10^{-5}$	[7}]
Te	$3,2 \cdot 10^{-5}$	$1,3 \cdot 10^{-2}$	$3,2 \cdot 10^{-9}$	$1,0 \cdot 10^{-5}$	[11]
Ti	$1,8 \cdot 10^{-1}$	$4,8 \cdot 10^{-5}$	$4,8 \cdot 10^{-8}$	$1,0 \cdot 10^{-7}$	
Tl	$6,4 \cdot 10^{-5}$	$2,0 \cdot 10^{-2}$	$6,40 \cdot 10^{-9}$	$8,0 \cdot 10^{-6}$	[7]
U	$2,3 \cdot 10^{-2}$	$1,0 \cdot 10^{-9}$	$1,0 \cdot 10^{-12}$	$1,0 \cdot 10^{-7}$	
V	$1,3 \cdot 10^{0}$	$5,10 \cdot 10^{-6}$	$5,10 \cdot 10^{-9}$	$5,0 \cdot 10^{-5}$	[7]
Zn	$5,3 \cdot 10^{-1}$	$6,5 \cdot 10^{-3}$	$6,50 \cdot 10^{-6}$	$3,0 \cdot 10^{-4}$	[7]