FluMet

Absorbent resin from Hungary for the removal of fluorine

Boron Fluorine Iodine Arsenic Mitigation Technology

S-Metalltech '98 Ltd

EDITION 2015-3

FluMet is a highly effective regenerable granular absorbent resin that removes fluorine from aqueous sources.

The main component of the **FluMet** product is the cerium-oxide as absorbent. In addition to this material this product contains only polymer substrate, thus they can be safely used for treatment of drinking water.

ION-EXCHANGE / ADSORPTION

$$Ce - OH + F^- \rightarrow Ce - F + OH^- \ (pH \leq 3.5)$$

REGENERATION / DESORPTION

$$Ce - F + NaOH \rightarrow Ce - OH + NaF$$

COMPARISON OF FLUORINE MITIGATION METHODS

The different methods for the removal of fluoride from water can be classified in these categories: adsorption method, ion exchange method, precipitation/coagulation method, miscellaneous methods (reverse osmosis).

Most widely used adsorbents are activated alumina and activated carbon. The advantages of carbonaceous materials, especially of modified activated carbons, are high adsorption capacities and partially good regeneration properties, but their maximum adsorption performances are usually strongly pH dependent. Although activated carbons are the most used adsorbents worldwide with high capacities, they are generally characterized by low selectivity for fluoride ions due to physical adsorption, so in most cases, activated carbons are modified by oxidation and subsequent impregnation with high valent ions such as zirconium, titanium, iron, calcium, etc.

Material	Total capacity
FluMet	≥23 g/l-Ad
Activated alumina	3 g/kg-R (alkaline) 5.6 g/kg-R (pH 7) 20 g/kg-R (acidic)

Table 1 Comparison of the total capacity of some absorbent material

The different ion exchange materials studied include bone, bone char, activated alumina, serpentine, anion and cation exchange resins. Water treated with poor bone charcoal may taste and smell like rotten meat and is aesthetically unacceptable. Defluoridation by activated alumina requires a relative long contact time.

In addition to the traditional and chemical-intensive fluorine mitigation methods **FluMet** is a specially developed filter resin that offers cost-effective, sustainable and low–power solution in water treatment.

PROPERTIES

FluMet does not need conditioning which is required when ion-exchange resin is used. Because of the absorptivity depends on pH, this should be adjusted. You have only to make pH of the water acid before passing it through to absorb fluorine ion.

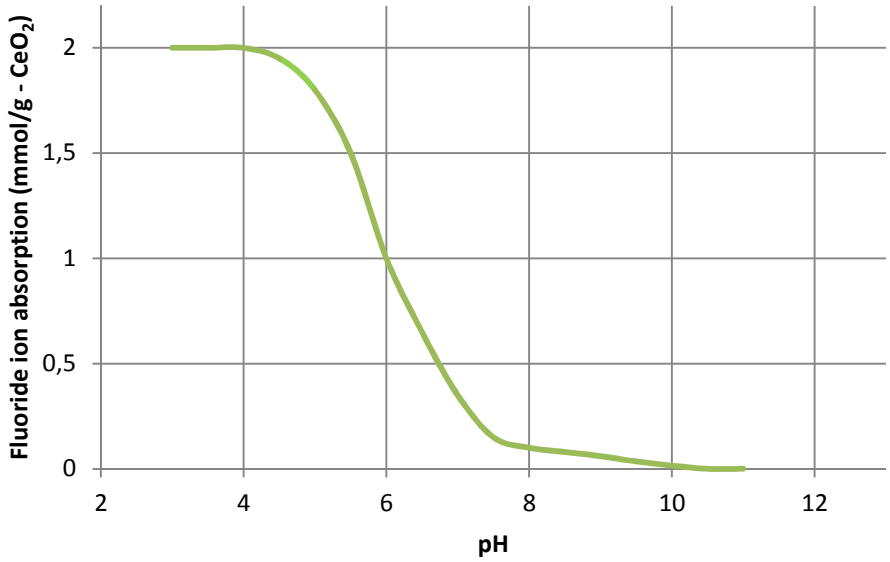


Figure 1 Effect of pH on fluoride ion absorption of hydrous cerium oxide

It is preferable to keep PO4 ion concentration at the level of 0.5 mg/L or less. PO4 ion is absorbed by the resin irreversible thus it is not removed by regeneration process and it is accumulated. It will block fluorine ion being absorbed, resulting in degrading of absorption capacity.

Permitted concentration of fluorine ion is 30 mg/L. If the concentration of fluorine ion is too high, the adsorbent (cerium) will be dissolved and this effect degrades the adsorption capacity gradually.

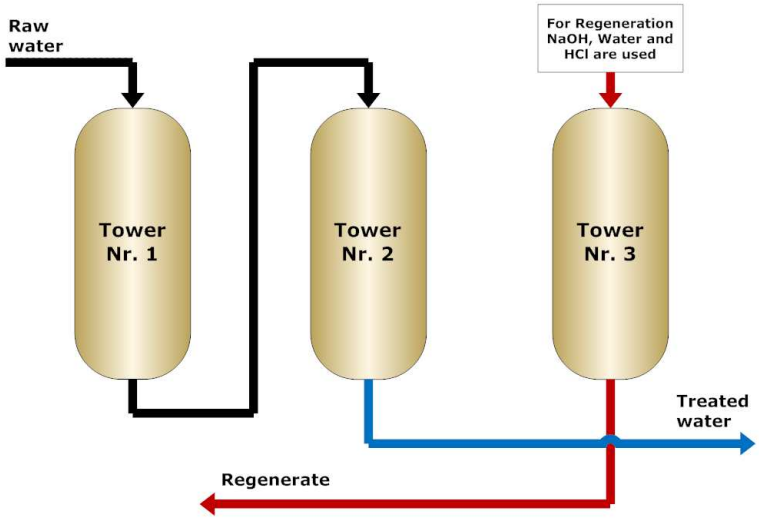
Product		FluMet
		Fluorine
Composition		Hydrated cerium-oxide embedded in polymer substrate
Properties	Adsorption[1] [g/l-Ad]	≥23
	Specific gravity	2.1
	Average bead size [mm]	0.7
Use conditions	Pretreatment	Not necessary
	pH	3.0 - 3.5
	Max. operating temperature [°C]	50
	Contaminants that have influence on adsorption efficiency	Oxidizing or reducing agents, $PO_4 3^-$, Al^{3+}, Fluorine compound
Condition of regeneration		NaOH, HCl

Table 2 Physical properties of FluMet

Expert engineers from S-Metalltech 98 ltd can participate in adaption of FluMet-based fluorine mitigation technology. Involving partner companies S-Metalltech 98 Ltd. is able to design and construct full waterworks.

[1] Test parameters of treated solution: fluoride concentration: 50 mg/L; pH: 3.0; SV: 10

PLANT DESIGN



The process consists of three absorbent towers. Two connected in series and the third is on standby. When the concentration at the outlet of the first tower exceeds the specified value, operation of the second and the third should take place and the first should put in regeneration process thus continuous operation can be realized.

Depending on the amount of the adsorbent material this solution is adaptable in various sizes (domestic, industrial) with the appropriate sized tanks.

COST FACTORS

The following items determine the price of the system:

- **Investment**:
  - Resin (7 years product life)
  - Equipment (containers, piping, fittings) capacity dependent value (for 20 years)
- **Running cost:**
  - *Regeneration*:
    - Chemicals
    - Hazardous waste destruction (with different sedimentation techniques the amount of regenerate can be reduced by 60 – 70 %)
  - Energy consumption:
    - Continuous operation: 0 EUR (does not require energy)
    - Pumps at regeneration process
  - Maintenance:
    - Requires backwash weekly
    - Requires a few hours of labor and hazardous waste (regenerate) removal at every regeneration cycles

INDUSTRIES WHERE HYDROFLUORIC ACID IS USED

- **Steel** industry
  Pickling agent to remove oxides and other impurities from stainless and carbon steels

- **Semiconductor** industry
  Etching agent

The U.S. has the capacity to produce roughly 250,000 tons of hydrofluoric acid annually (206,000 tons in 1992). The United States is not the largest producer. The hydrofluoric acid consumption in China in 2009 was 917,000 tons.

Sources	Emission Tons/Year
Steel	40100
Ceramics	21200
Aluminium Industry	16000
Welding operations	27000
Phosphet fertilizer and processsing Industry	18700
Combustion of coal	16000
Non Ferrous metal foundries	4000

Table 3 Estimated total inorganic fluoride emission from major industries in the United States

FLUORIDE IN GROUNDWATER

Fluoride has a significant mitigating effect against dental caries if the concentration is approximately 1 mg/L. However, continuing consumption of higher concentrations can cause dental fluorosis and in extreme cases even skeletal fluorosis. High fluoride concentrations are especially critical in developing countries, largely because of lack of suitable infrastructure for treatment[2]. Fluoride is a common constituent of groundwater. Natural sources are connected to various types of rocks and to volcanic activity. Agricultural and industrial activities also contribute to high fluoride concentrations in groundwater.

Name of organization	Permissible limit of fluoride ion (mg/L)
World Health Organization (International standard for drinking water)	0.50
US Public Health Standard	0.8
The committee on public health engineering manual and code of practice, Government of India	1.00
Indian Council of Medical Research recommendations	1.00
ISI recommendations	1.50

Table 4 Permissible limit of fluoride in drinking water prescribed by various organizations

[2] http://www.wateraid.org

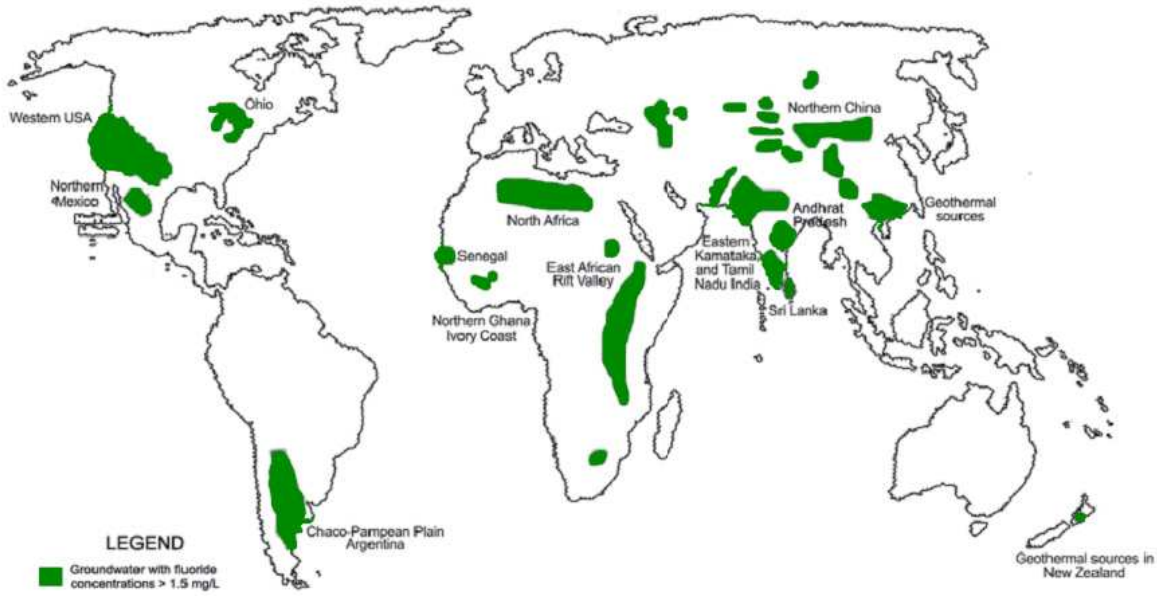


Figure 2 Groundwater with fluoride concentration >1.5 mg/L [3]

Figure 3 Unfortunate examples of dental and skeletal fluorosis

[3] A systematic review of the efficacy and safety of fluoridation PART A: Review of methodology and Results

PROBABILITY OF OCCURRENCE OF EXCESSIVE FLUORIDE CONCENTRATIONS

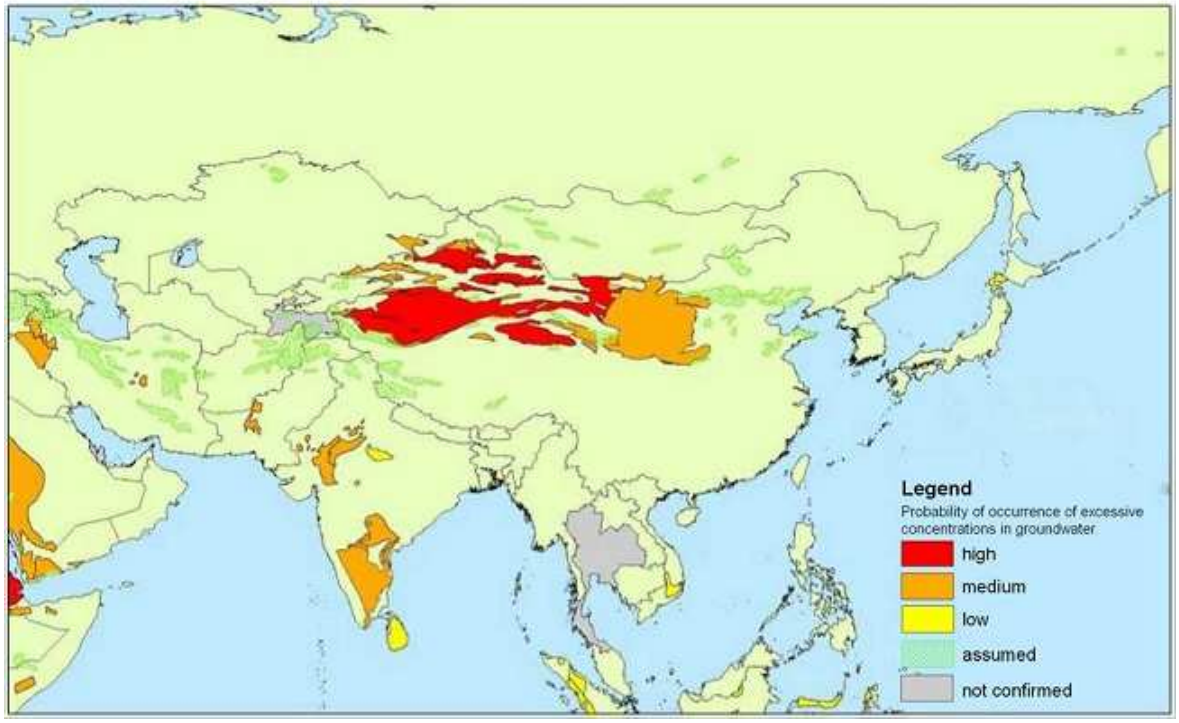


Figure 4 Fluoride in groundwater in Asia

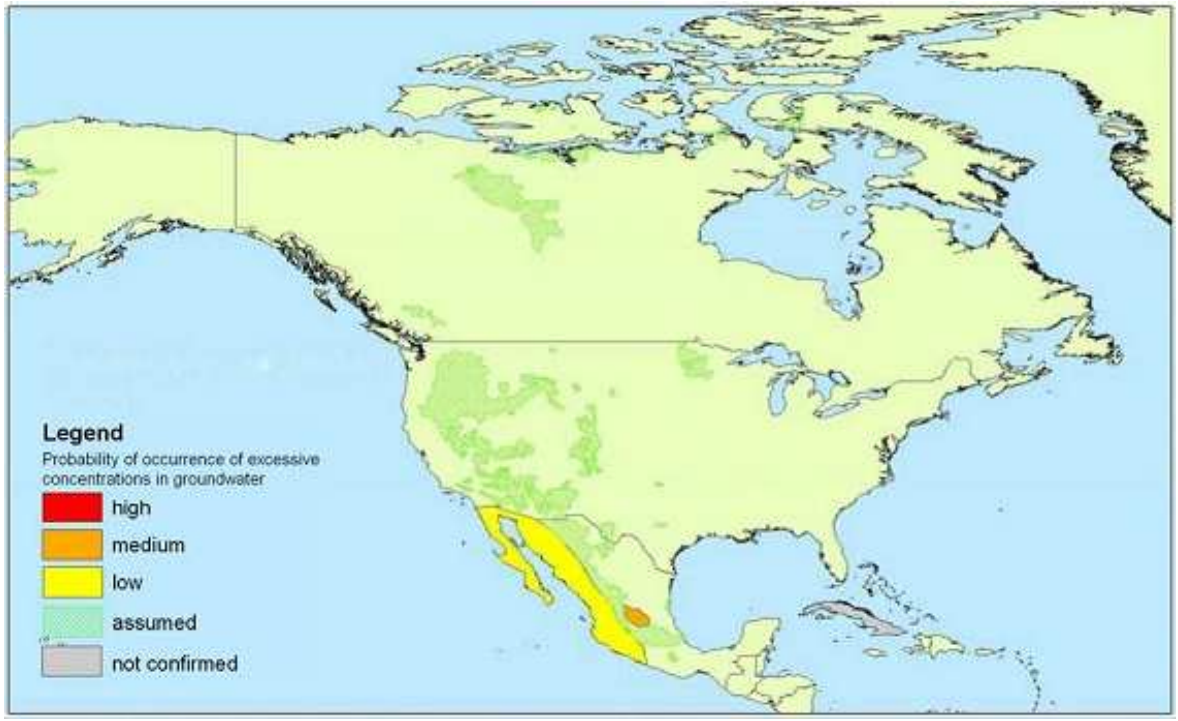


Figure 5 Fluoride in groundwater in North and Central America

Figure 6 **Fluoride in groundwater in South America**

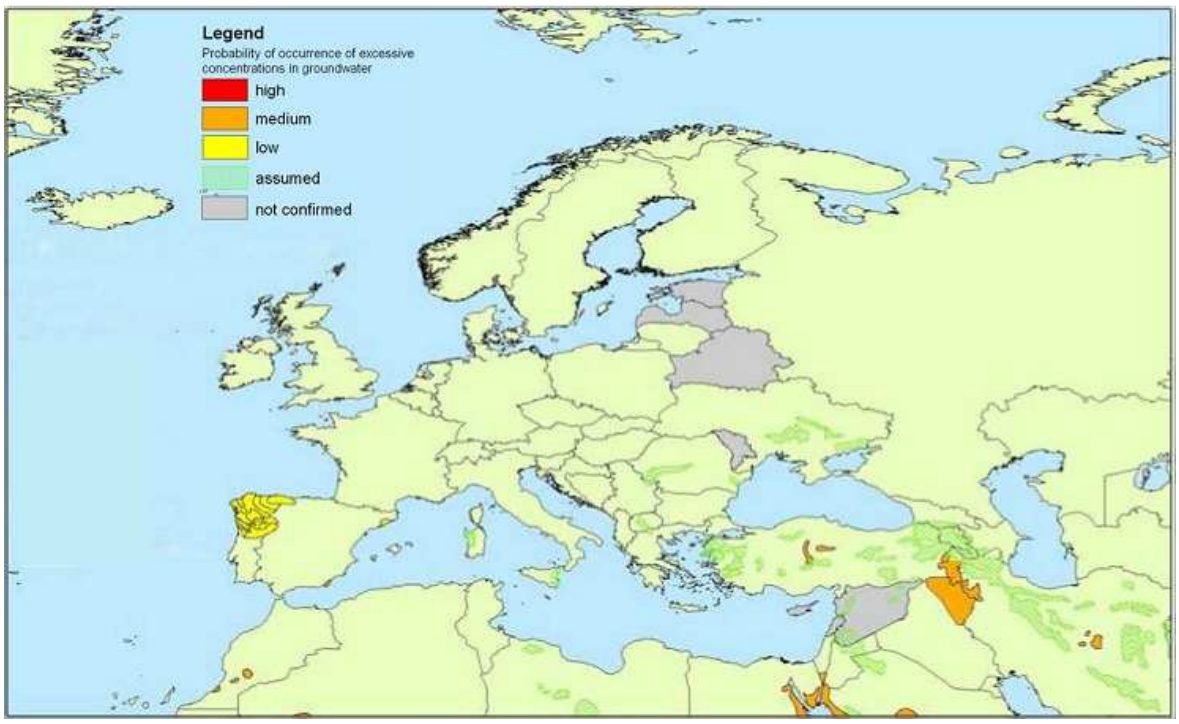


Figure 7 **Fluoride in groundwater in Europe**

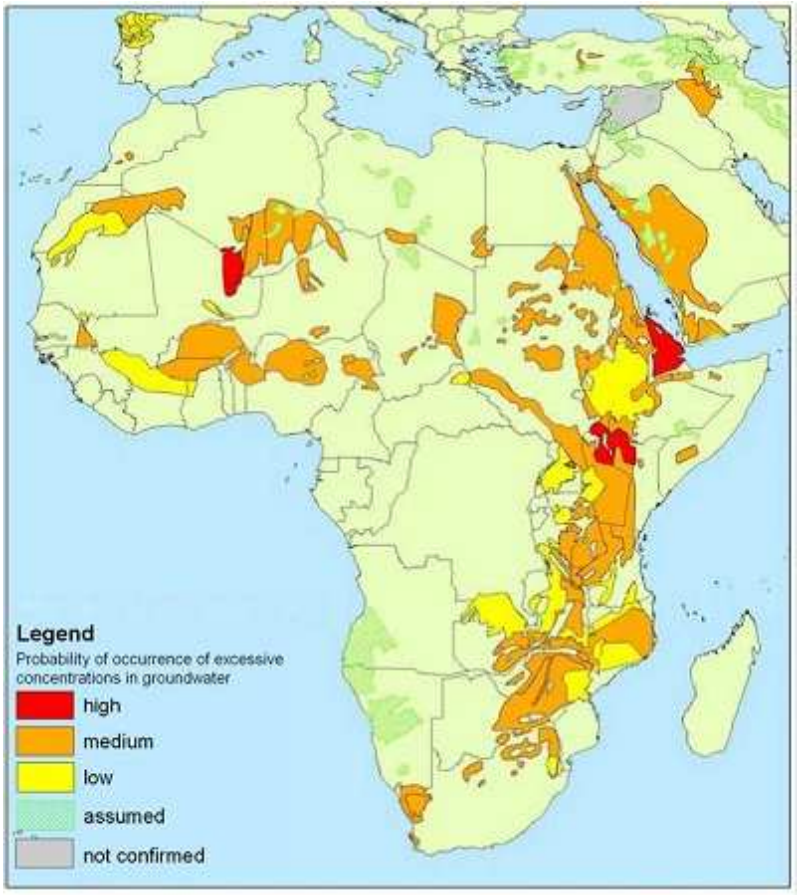


Figure 8 Fluoride in groundwater in Africa

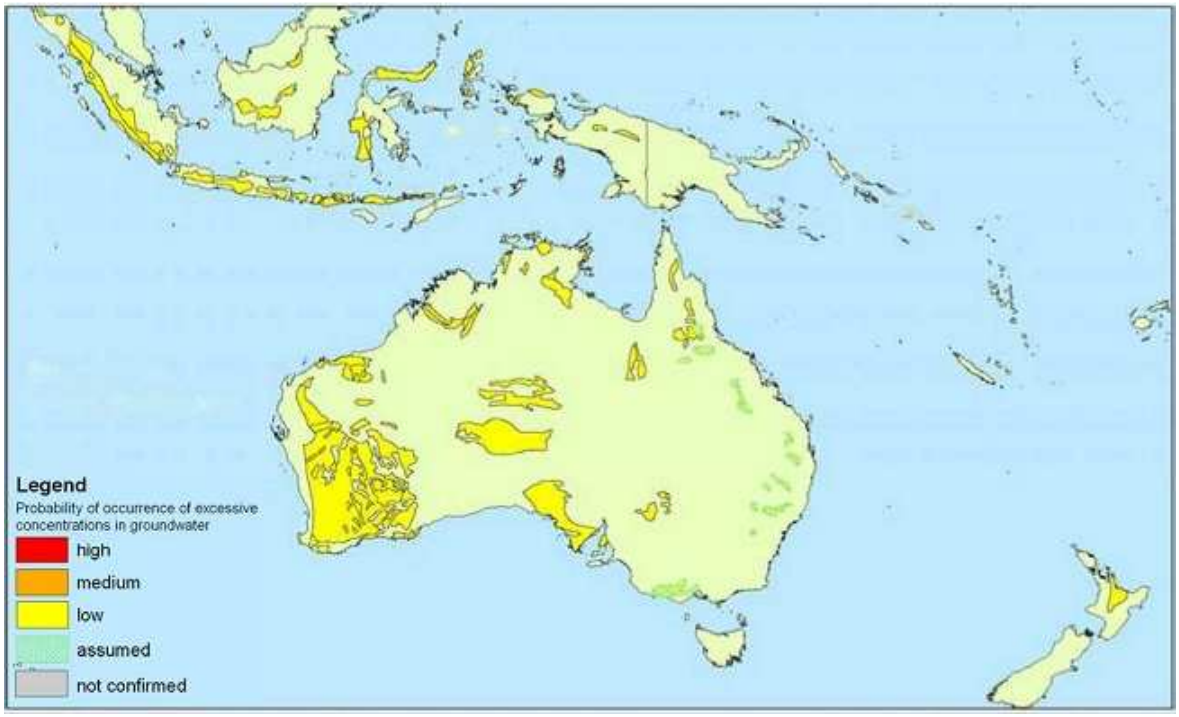


Figure 9 Fluoride in groundwater in Australia

FACTORY

LOCATION

Industrial Park Jászfényszaru
2532/3 Jászfényszaru
Hungary

CONTACT

S-Metalltech 98 Materials Research and Development Ltd.
H-1037 Budapest Zay utca 3.
Hungary
www.smet.hu / www.arzenmentesites.hu
E-mail: info@smet.hu
Phone: +36-1-367-92-91

Boron Fluorine Iodine Arsenic Mitigation Technology

S-Metalltech 98 Ltd