Trace elements in groundwater in Latvia: existing data and first new results

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INTRODUCTION

The territory of Latvia is a part of the Baltic Artesian (Sedimentary) basin which can be subdivided in *three major water exchange zones*: freshwater (active water exchange), saline (delayed exchange), and brines (stagnant) hydrogeological zones considering water chemistry and intensity of water connection between aquifers.

Trace element occurrence in groundwater can be due to natural sources such as dilution of water bearing rocks, surface impact or anthropogenic influence.

MATERIALS AND METHODS

Groundwater samples from monitoring and supply wells as well as boreholes and springs are analyzed by **total x-ray fluorescence** (TXRF) and **atomic absorption spectroscopy** (AAS) techniques to determine the concentration of trace and some major elements. At the end of the study there will be new data about approximately two hundred groundwater samples (Table 1). Contents of cations and anions, *pH*, electrical conductivity (EC), redox potential (ORP), TDS and dissolved oxygen are analysed to assess the quality of groundwater.

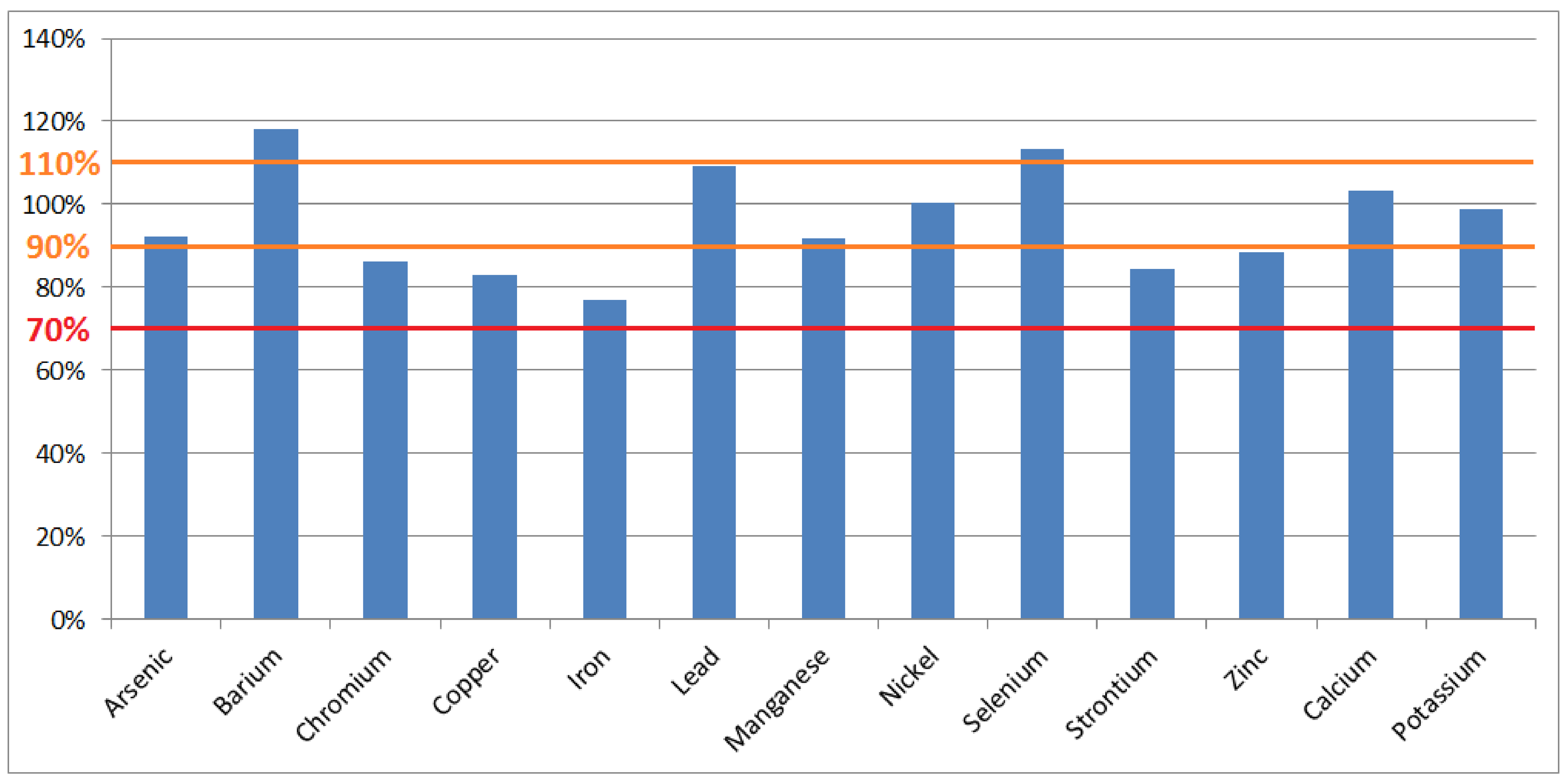

Figure 1. **Recovery data for the ERM-CA011 drinking water reference by TXRF PicoTax**

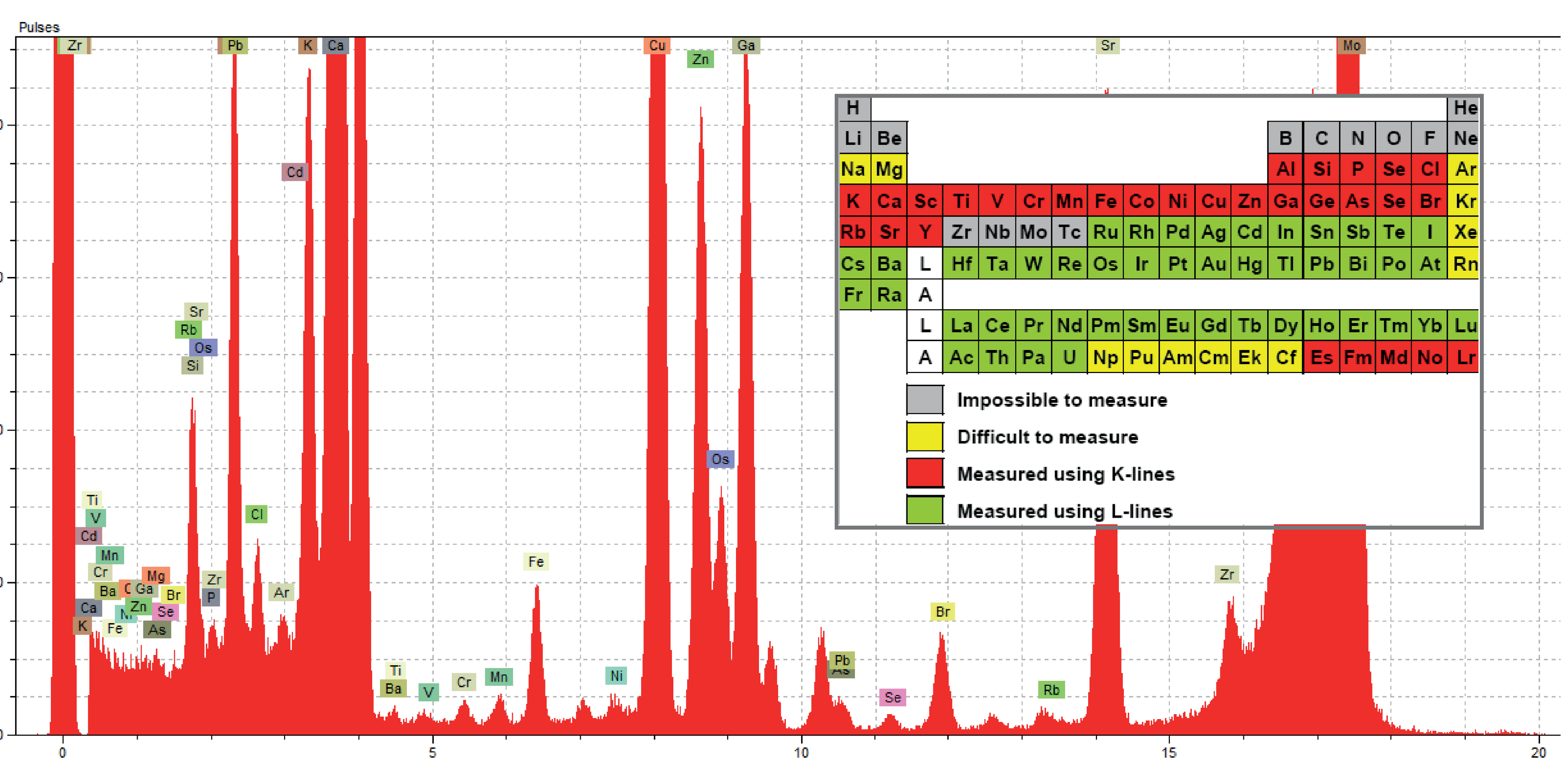

Figure 2. **Overview of the measurability of elements using the PicoTAX spectrometer and the typical energy dispersive spectra of the PicoTAX (ERM-CA011 reference)**

THE AIM OF THE STUDY

Two main types of data sources are available *on groundwater trace element concentration* in Latvia:

1) the data from geological mapping and hydrogeological exploration during Soviet times,

2) recent studies, particularly „Agricultural influence on groundwater in Latvia".

It is impossible to test the quality of the first; therefore, the old data is incomparable to data obtained by modern methods. The second data source is mainly limited to Quaternary sedimentary aquifer susceptible to agricultural influence.

Table 1

Stratification of hydrogeological cross-section; existing data and new results on groundwater trace element concentration and planned sampling sites *(Gosk et al., 2006; Levins et al., 1998)*

<table>
<tr><th>Hydrogeological Zones</th><th>Multi-aquifer system</th><th>Main aquifers</th><th colspan="2">Existing data (Gosk et al., 2006)</th><th colspan="2">New results and planned sampling sites</th></tr>
<tr><td rowspan="14">Active water exchange (freshwater)</td><td>Q</td><td></td><td colspan="2">612</td><td colspan="2">45</td></tr>
<tr><td colspan="2">P_2</td><td colspan="2">4</td><td colspan="2"></td></tr>
<tr><td colspan="2">C_1</td><td colspan="2">2</td><td colspan="2"></td></tr>
<tr><td rowspan="2">D_3fm</td><td>D_3mr-ktl</td><td colspan="2">5</td><td colspan="2">5</td></tr>
<tr><td>D_3jn-ak</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="5">D_3pl-aml</td><td>D_3st</td><td colspan="2">1</td><td colspan="2"></td></tr>
<tr><td>D_3kt-og</td><td colspan="2">12</td><td colspan="2">3</td></tr>
<tr><td>D_3dg</td><td>12</td><td rowspan="3">5</td><td>2</td><td rowspan="2">2</td></tr>
<tr><td>D_3slp</td><td>18</td><td>2</td></tr>
<tr><td>D_3pl</td><td>45</td><td colspan="2">10</td></tr>
<tr><td rowspan="4">$D_{2-3}ar$-am</td><td>D_3am</td><td colspan="2">14</td><td colspan="2">13</td></tr>
<tr><td>D_3gj</td><td colspan="2">39</td><td>28</td><td rowspan="2">1</td></tr>
<tr><td>D_2br</td><td colspan="2">19</td><td>8</td></tr>
<tr><td>D_2ar</td><td colspan="2">3</td><td colspan="2">3</td></tr>
<tr><td colspan="7">Regional Narva aquitard D_2nr</td></tr>
<tr><td rowspan="4">Delayed water exchange (saline)</td><td rowspan="4">D_{1-2}</td><td>D_2pr</td><td colspan="2">1</td><td colspan="2">4</td></tr>
<tr><td>D_2rz</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>D_1km</td><td colspan="2"></td><td colspan="2">15</td></tr>
<tr><td>D_1gr</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">Ordovician and Silurian water proof formation O-S</td><td colspan="2">2</td></tr>
<tr><td>Stagnant (brines)</td><td>C</td><td></td><td colspan="2"></td><td colspan="2">1</td></tr>
<tr><td colspan="7">Lontova water proof formation C_1ln</td></tr>
</table>

RESULTS AND CONCLUSIONS

Previous studies suggest that the influence of lithology of aquifer deposits on concentrations of trace elements is statistically significant only in cases where aquifer deposits are rich in organic matter or contain well-soluble minerals (Levins and Gosk, 2007).

Some exceeding trace element concentrations are associated with gypsum dissolution in shallow groundwater samples. Studies show that concentration of barium, iron, lithium and strontium get higher with increasing residence time and confinement degree of an aquifer (*ibid*).

TXRF can be used to determine trace element concentration up to ug/l range. Good recovery data can be observed for As, Pb, Mn, Ni (±10%) and Cr, Se, Sr, Zn (±15%)and with restrictions for Ba, Cu, Fe, K, Ca. Extreme care must be taken durind sample preparation to avoid sample contamination with Zn, Fe, Ba, K and Ca.

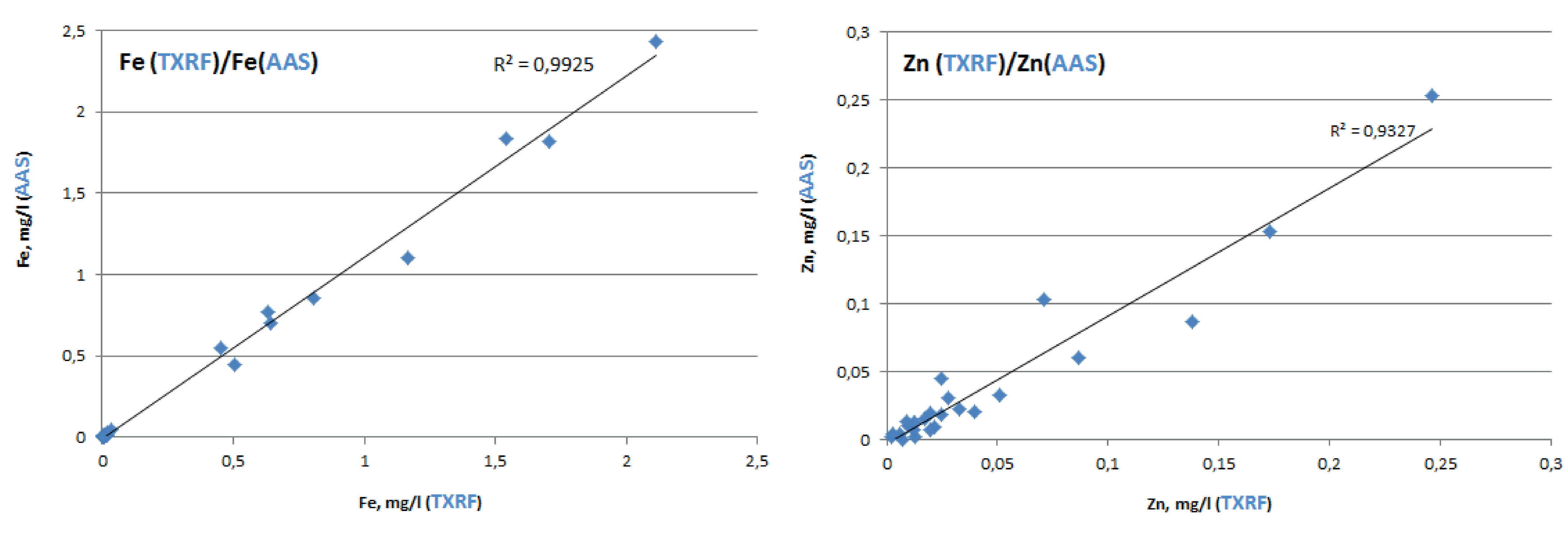

Figure 3. **Result measured by AAS and TXRF comparision**

Acknowledgement

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