High concentrations of Rn in soil air reveal a fracture zone in the bedrock of the Tapa area, Estonia

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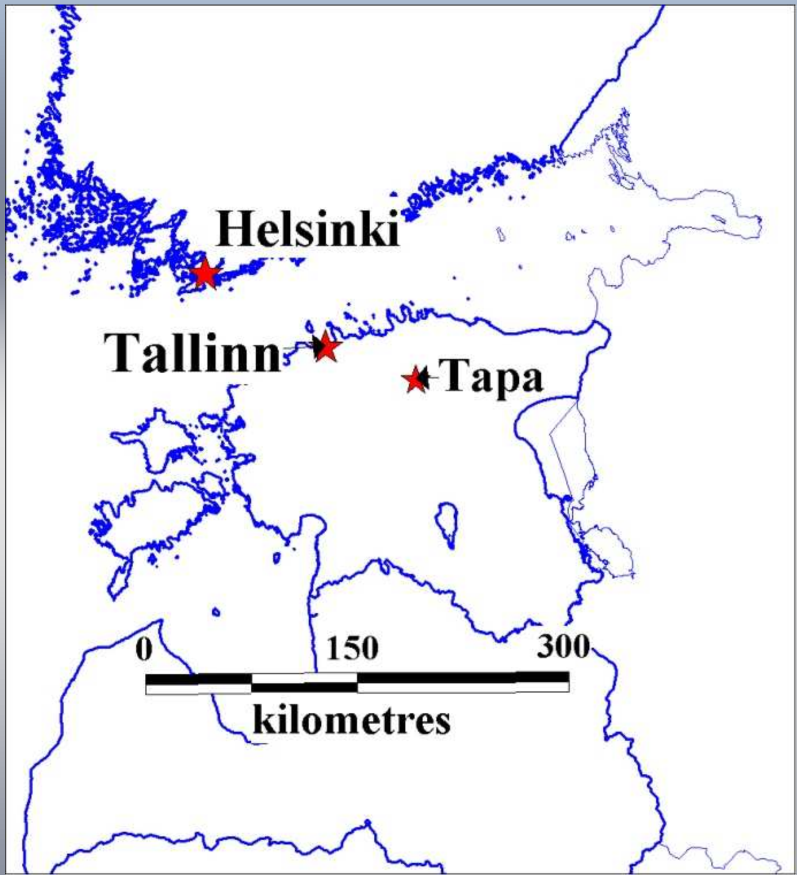
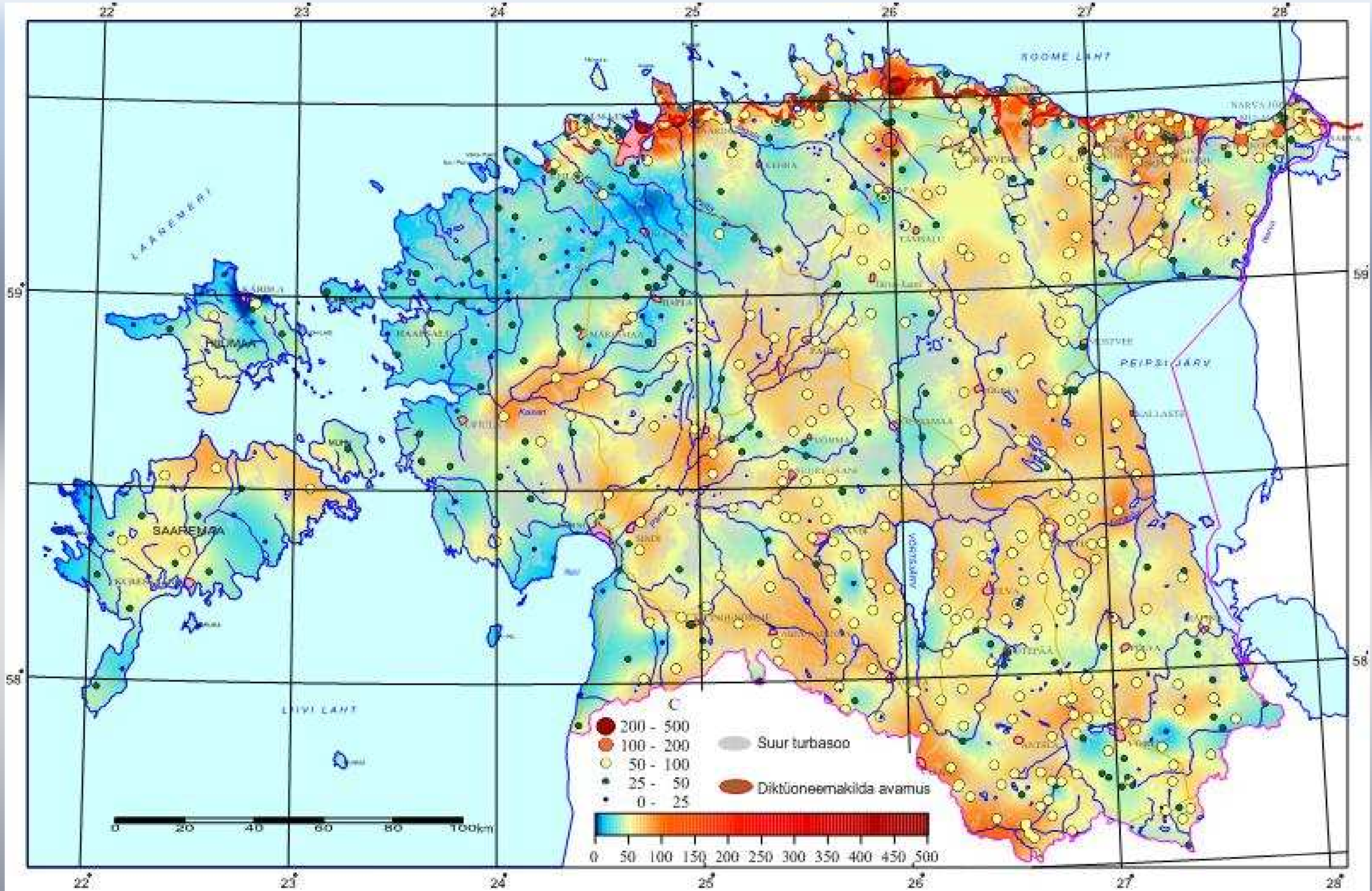
Geological Survey of Estonia



- Results of radon risk mapping in 2002 up to 2004
- Geological background
- Geological background in Tapa area
- The result of Rn measurements in Tapa area
- Conclusions



- **The Radon Risk Map of Estonia above (Petersell *et al.*, 2004) shows that Estonia is a country of high radon risk.**
- **The Radon concentration in the soil air exceeds the maximum concentration for unrestricted building activity (50 kBq/m^3) by three times on about one third of the territory.**
- **The Risk Map also showsthat the Rn in soil air is especially high in northern Estonia**

Radon risk mapping revealed clearly that high concentrations of Rn **are caused** by outcrops of uranium-rich Lower Ordovician rocks, **graptolitic argillite** and **phosphorite (Obolus sandstone)** along the limestone escarpment of the north Estonian coastline, *i.e.* the North Estonian Klint

Graptolitic argillite

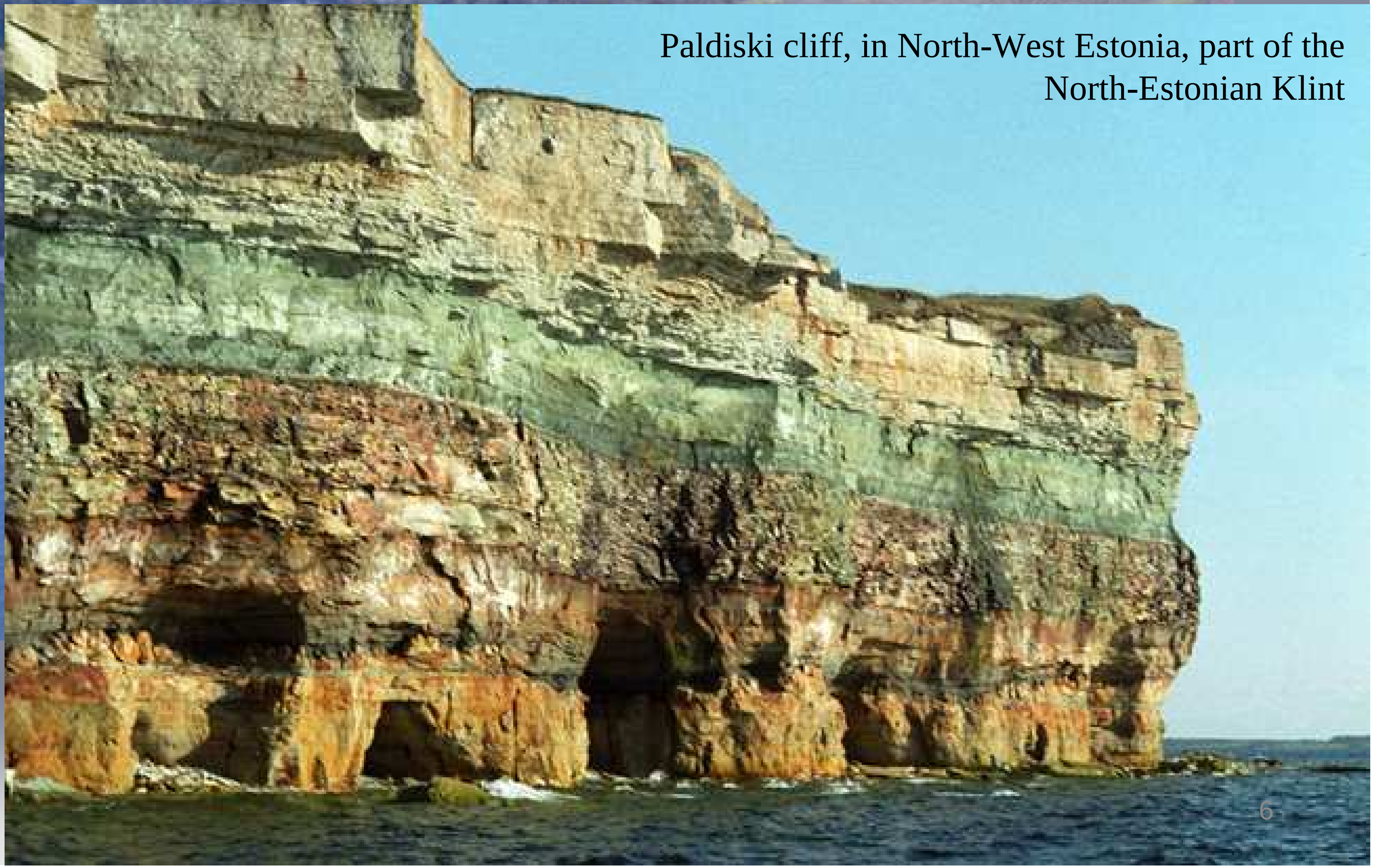
The uranium content in graptolitic argillite varies around 30–300 ppm in average

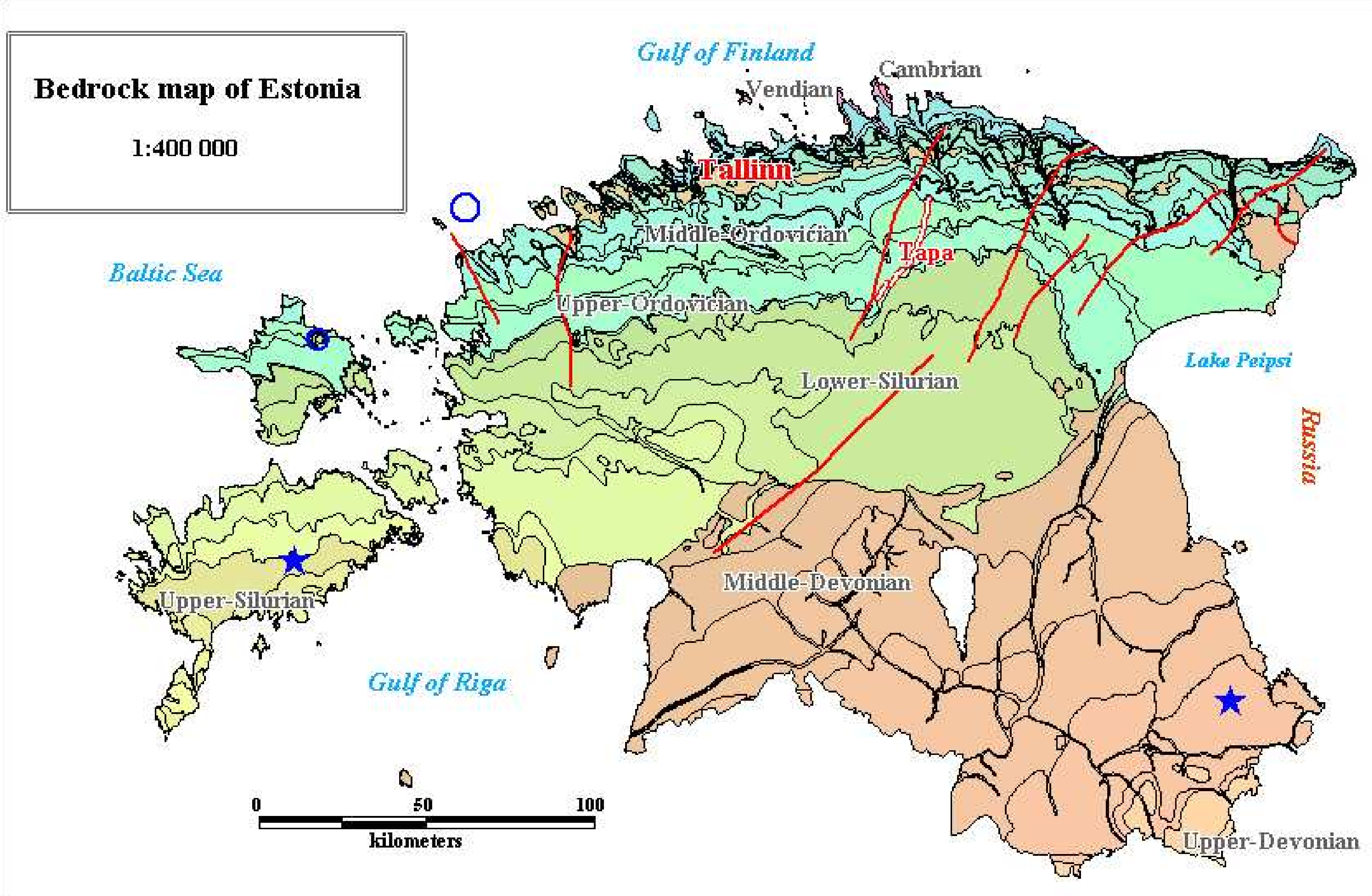
Phosphorite (Obolus sandstone)

The uranium content in phosphorite varies around 4–30 ppm in average

Päite cliff, in North-East Estonia, part of the North-Estonian Klint

Paldiski cliff, in North-West Estonia, part of the North-Estonian Klint





Bedrock map of Estonia
1:400 000
Gulf of Finland
Cambrian
Vendian
Tallinn
Middle-Ordovician
Tapa
Baltic Sea
Upper-Ordovician
Lake Peipsi
Lower-Silurian
Russia
Middle-Devonian
Upper-Silurian
Gulf of Riga
0
50
100
kilometers
Upper-Devonian

The **biggest impact** of **graptolitic argillite** and **phosphorite** becomes evident:
(i) directly on the outcrops and subcrops on the escarpment or on the slope of the klint,
(ii) on the plain in north of the klint and
(iii) within a 5–15 km wide zone on the limestone plateau south of the klint. (Petersell *et al.*, 2004).

During the radon risk mapping high radon **concentrations connected to tectonic faults were not identified**.

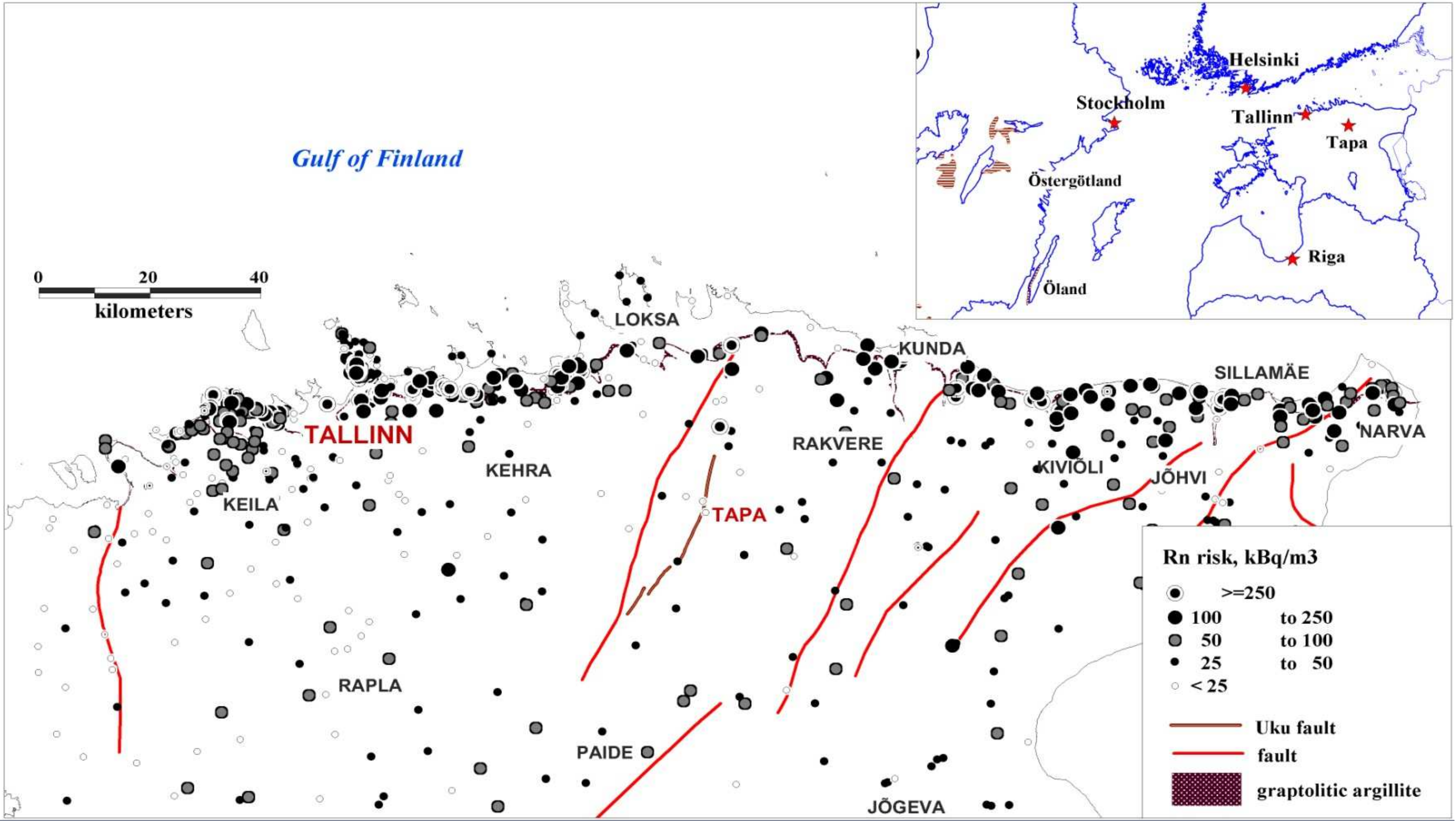


Figure 1. Distribution of radon in soil air by Rn risk mapping 2002-2004.

On 14 March 2011, south of Tapa ~itself 30 km south of the North-Estonian klint, the results obtained with Markus-10 in soil air fluctuated from 72 up to 105 kBq/m^3, by eU from 17 up to 28 kBq/m^3. When, after 10 days, measurements were repeated the result was similer.

The first thought was that this results could be explained by **frozen ground;** but in June 2012 additional measurements confirmed the high radon risk in the area.

Altogether, there **is evidenc**e that **high radon** concentration south of Tapa **derives f**rom **the uranium-rich Lower Ordovician graptolitic argillite** and **phosphorite** layers underlying the limestone. It is possible for the radon gas to **seep through a fractured limestone complex**.

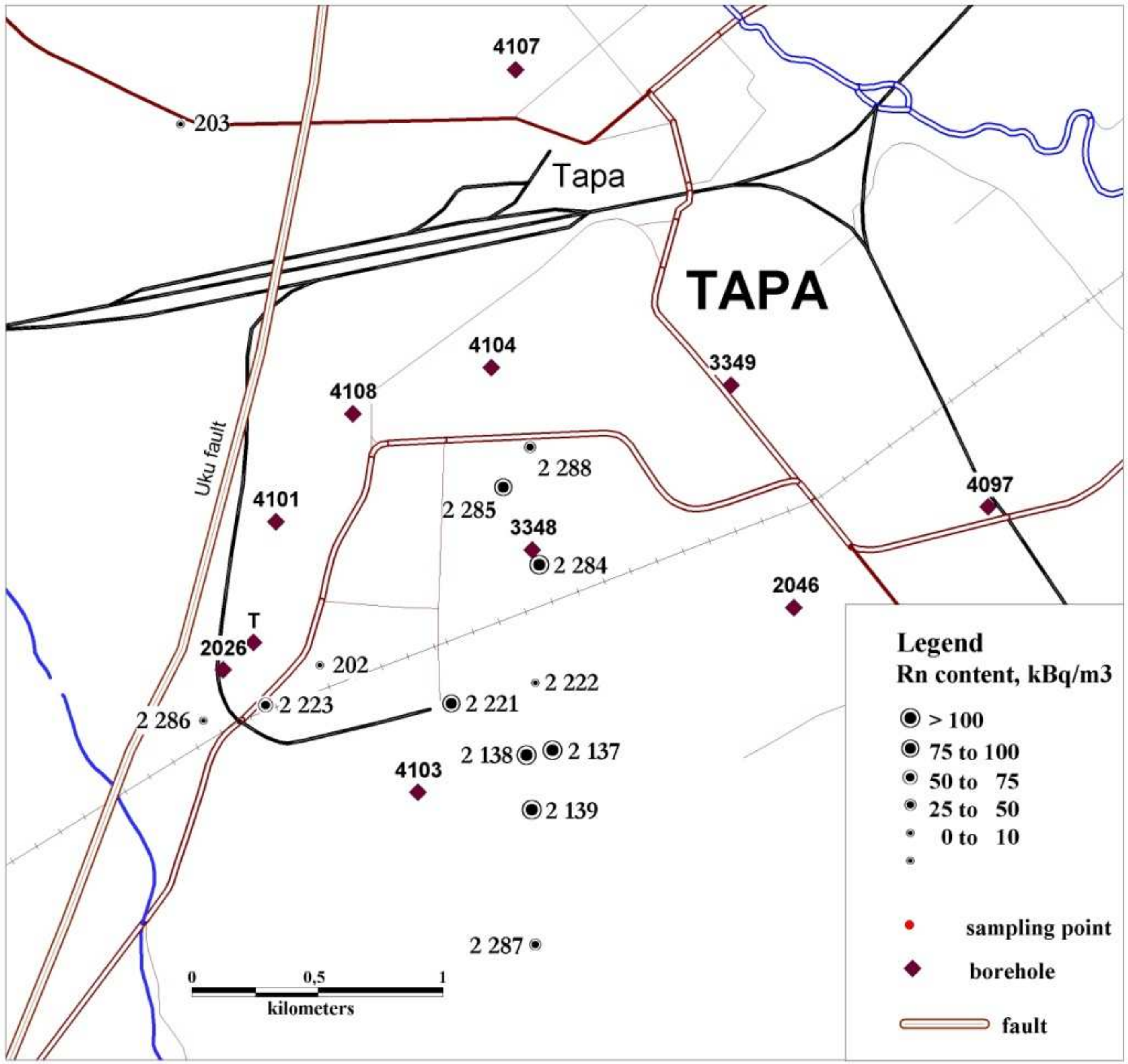


Figure 3.
Radon risk map of south of town Tapa 2012

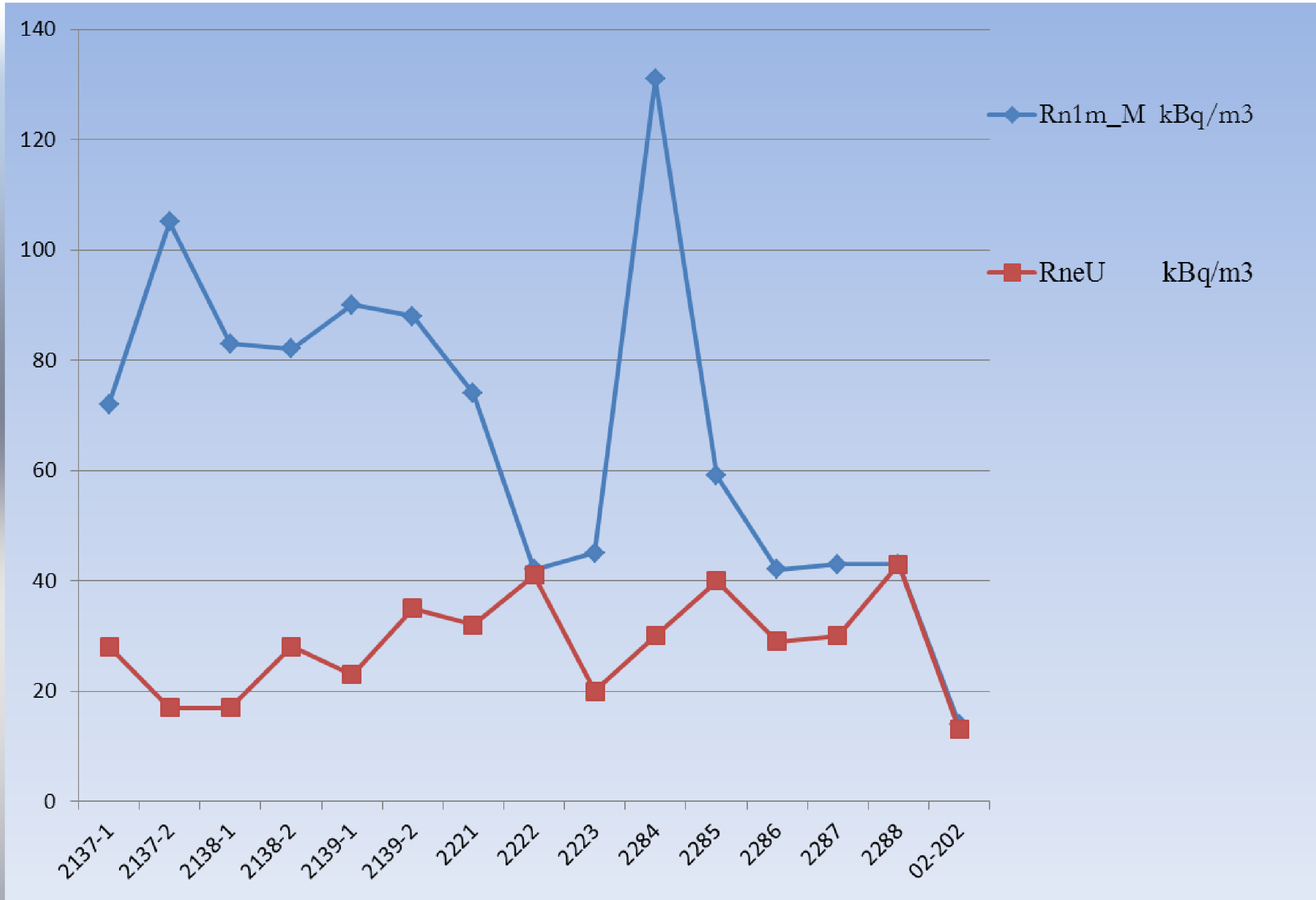


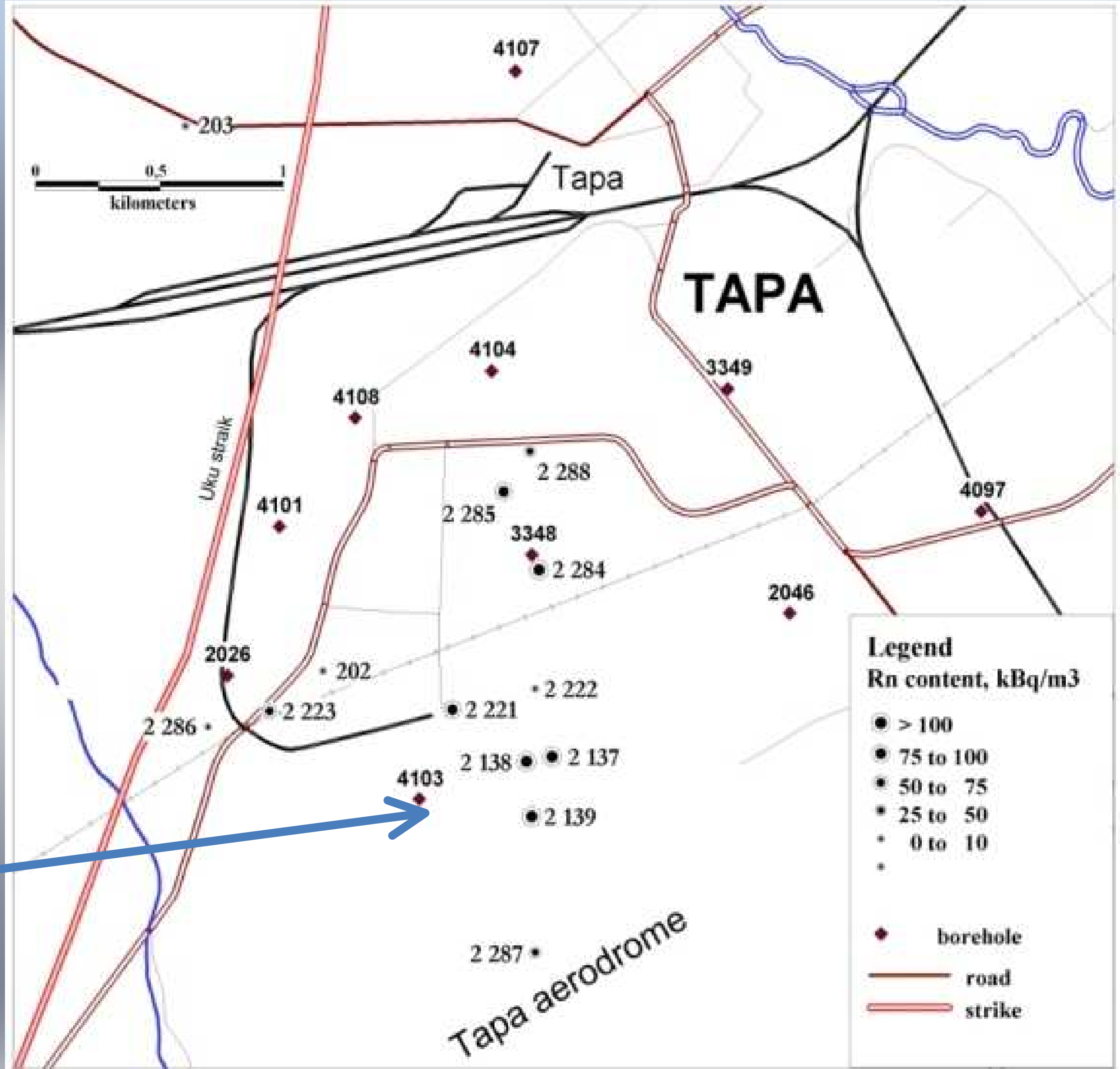
Figure 4. Our results, and the difference between direct and calculated measurements.

This kind of measurements were not expected because this region was identified as an area of normal radon risk during the 2002–2004 mapping.

For clarifying the cause of such high results, **drill logs** of the closest hydro-geological boreholes were examined.

Cross-sections of the boreholes show that the base of the limestone section lies at a **depth of 124 to 136 m.** Such a large **difference in depth** within a limited territory **implies fracturing** in the otherwise near-horizontal rock section.

The log **of borehole 4103** points out that the limestone was **jointed throughout the section allowing the Rn to seep through the limestone complex above**.



Conclusions

Examination of Rn risk south of the Tapa town reveals that

- Rn easily **reaches up to** the **surface in fractured zones, even from a depth of 130+m,** of the north Estonian limestone plateau, when the **Quaternary** cover **is thin**.
- This phenomenon **extends much further to the south** than was determined while the Radon Risk Map of Estonia was compiled.

Thus we state that in north Estonia, all the regions where **Ordovician limestone crops out** should be defined as **Rn risk areas** in which **Rn measurements** are **recommended before construction work**.

Thank you for attention!