Radon from building materials –
Reducing risk by monitoring at source

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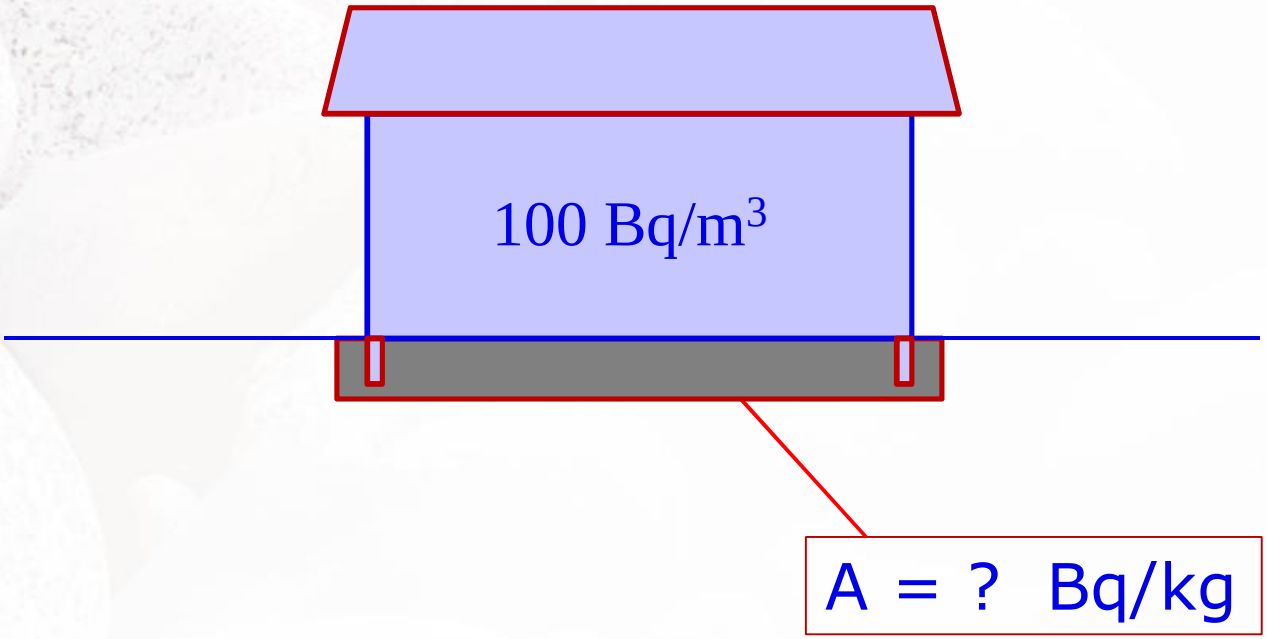
Statens strålevern
Norwegian Radiation Protection Authority

NGU
Norges geologiske undersøkelse
Geological Survey of Norway



- Drainage material may be sourced from U-rich quarries
- We may have **imported** a radon problem

AIMS:

Åinvestigate measurement methods

Åselect measurement method

Åestablish threshold values

Åestablish procedure for use in industry

OUTLINE:

1. Background
   - existing/previous recommendations
2. Measurement methods
   - overview
   - evaluation
3. Threshold value
   - modelling (RnMod3)
4. Procedure for industry

Existing / previous recommendations

- Gamma Index (EC 1999 112)

  $I = A_{Ra} / 300 + A_{Th} / 200 + A_K / 3000$

  $I < 1$

- Nordic RPAs (2000)

  $A_{Ra} < 200$ Bq/kg

- NRPA (1995 - no longer valid)

  transported material under or around new buildings: $A_{Ra} < 300$ Bq/kg

  ... 150 Bq/kg?.....

Measurement methods

Location:

- building site / quarry?
- production material / unblasted rock?

Methods:

- Gamma-spec (hand-held / lab)
- Chemical analysis (lab)
- Radon gas

Some issues to consider:

- background radiation in quarry environment
- equilibrium U/Ra
- measurement standards
- practical/cheap/quick

Gamma-spec instruments
ÅGR-256
ÅRS-125

Å4 quarries, Østfold
Åhigh U – some > 40ppm

Select samples that can also be removed for lab analysis

Calibration on NGU K/U/Th pads

Regular background measurements on lead plate

Procedure in quarries

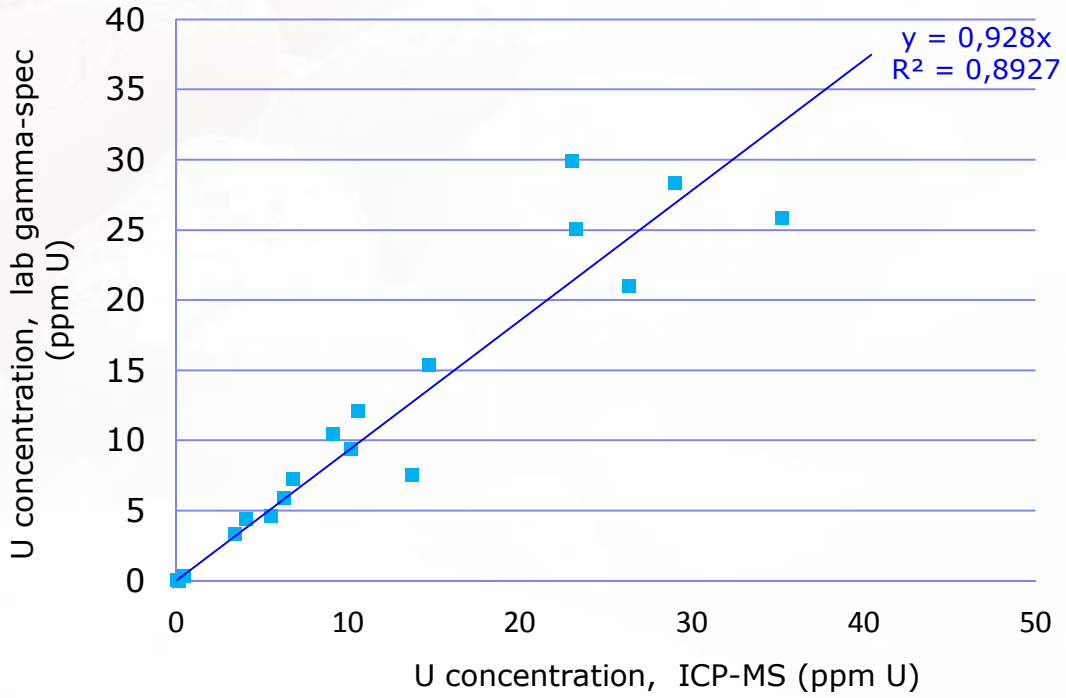
- Select ca 40 rocks, measure with GR-256 / RS-125
- Break-up rock, select several kg material nearest to spectrometer
- This material sent for lab analysis

Lab analysis

- Material prepared at NGU
  - crushed to various fractions, mixed
- sent to NRG, Netherlands (Rn exhalation + Gammaspec)
  - NEN 5699 (gas)
  - NEN 5697 (gamma)
- sent to ACME, Canada (Chemical analysis)

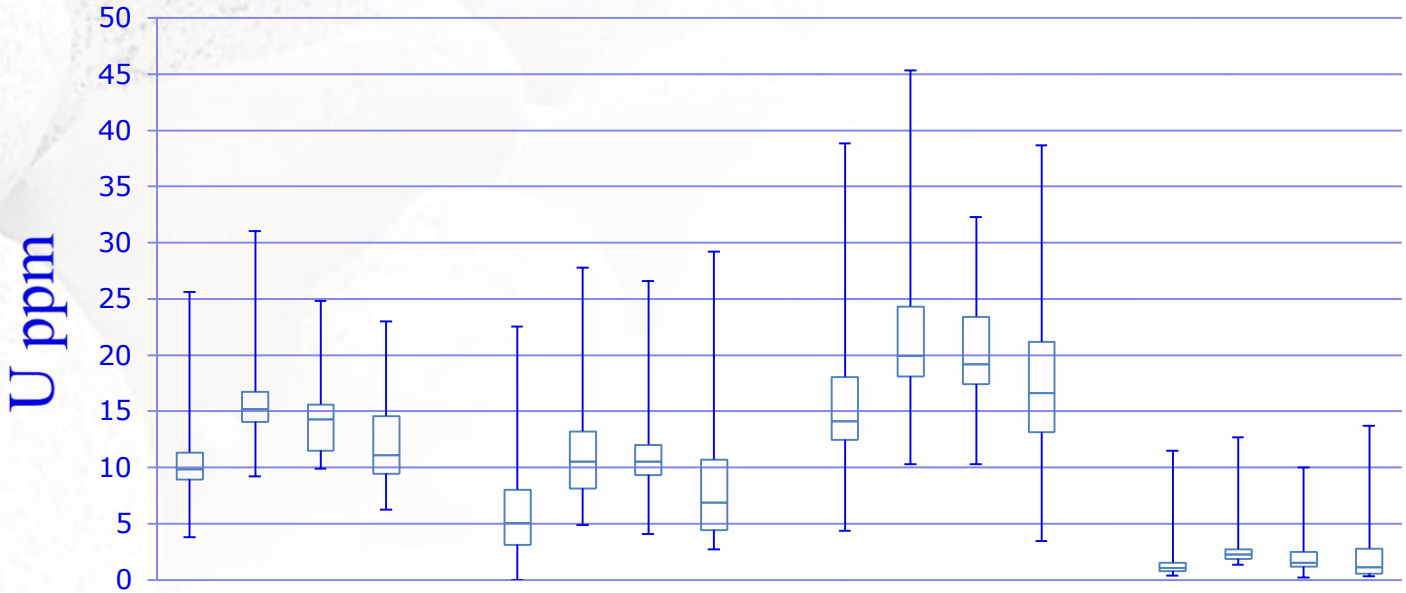
- Total 150 samples, 17 sent to NRG (gas, gamma)

Lab gamma vs Lab chemical



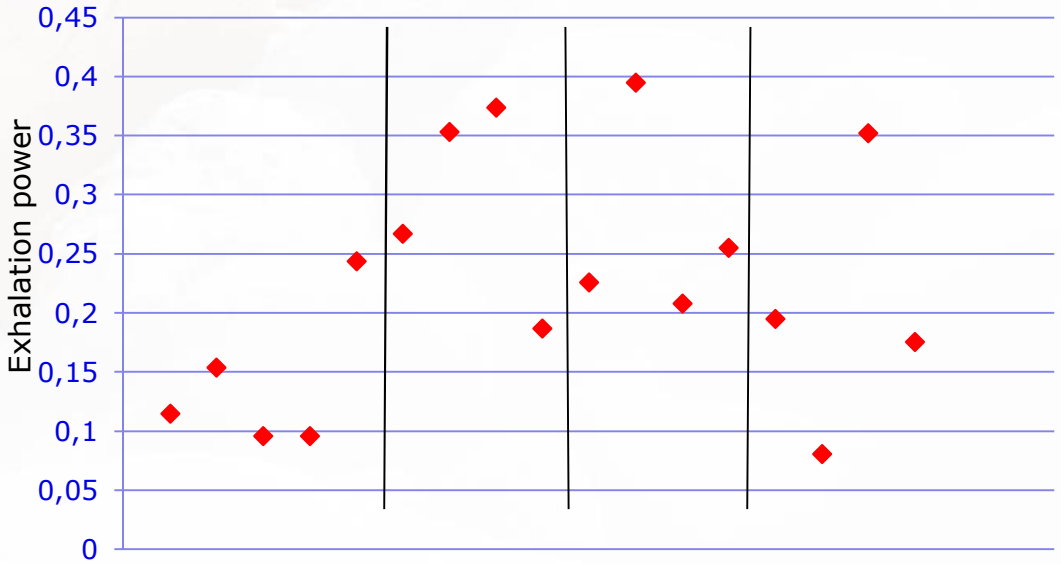
gradient = 0.928

Lab vs field measurements



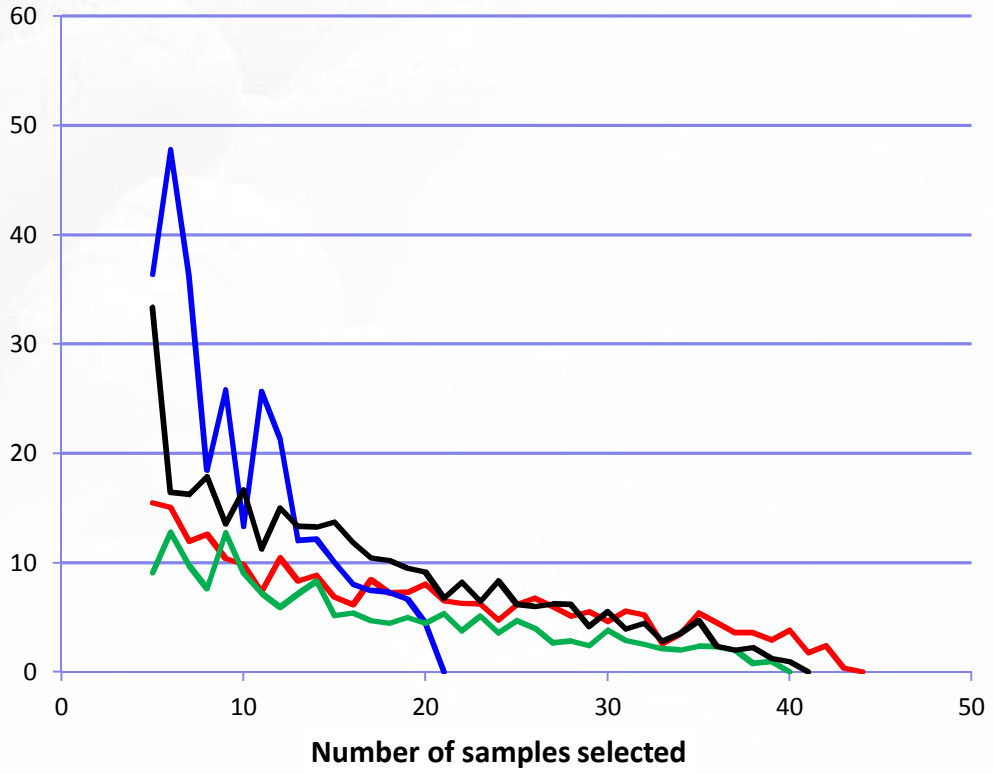
In each group of four:
ÅGR-256 background-corrected
ÅGR-256 collimation only
ÅRS-125 (factory calibrations)
Ålab chemical analysis

Exhalation power (NRG)



Mean = 0.23 (s.d. 0.10)
Fraction 0.063-2 mm

RSD vs number of samples



=> min 20 samples to characterise quarry

Conclusions from field/lab measurements:

ÅHand held gamma spec can give elevated values

ÅCan correct with appropriate shielding, but impractical

ÅLab chemical analysis (U):
- Åproxy for Ra content
- Årelatively cheap/fast method

Conclusions from exhalation measurements:

- Exhalation fractions in range 0.1-0.4
- Linear trend (exh fraction vs activity)
- Time consuming, relatively expensive procedure

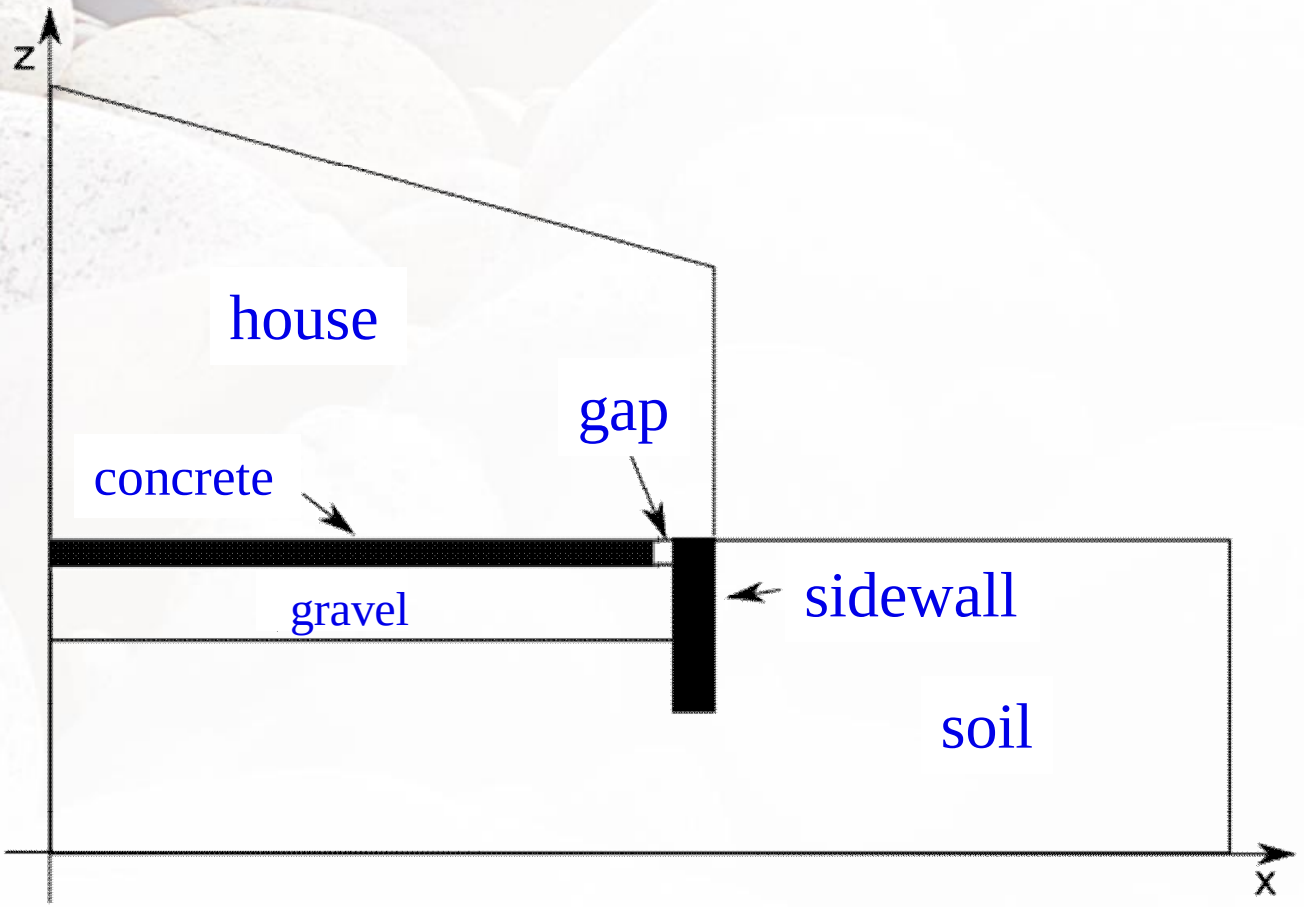
=> recommend lab chemical analysis method

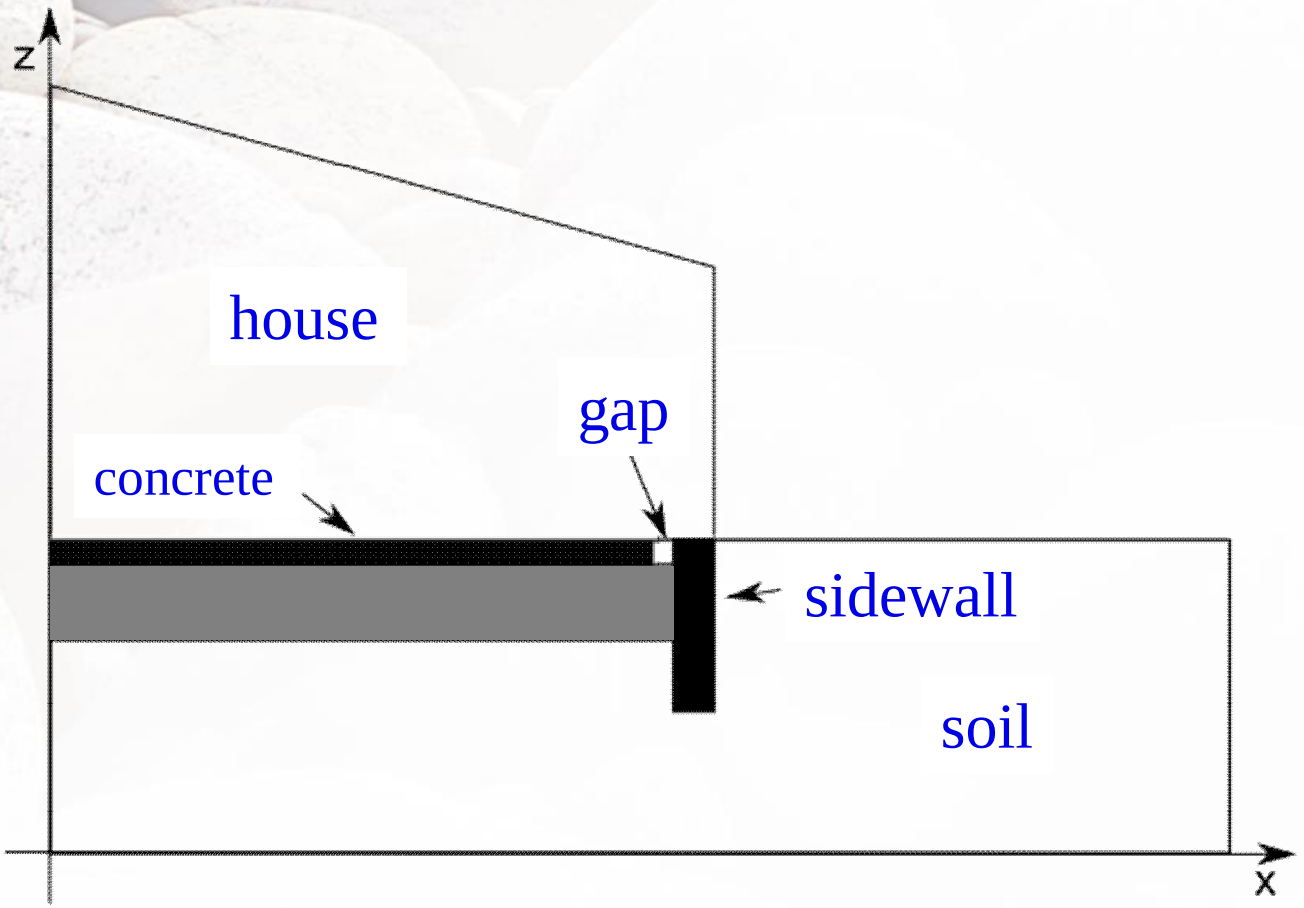
Threshold value:

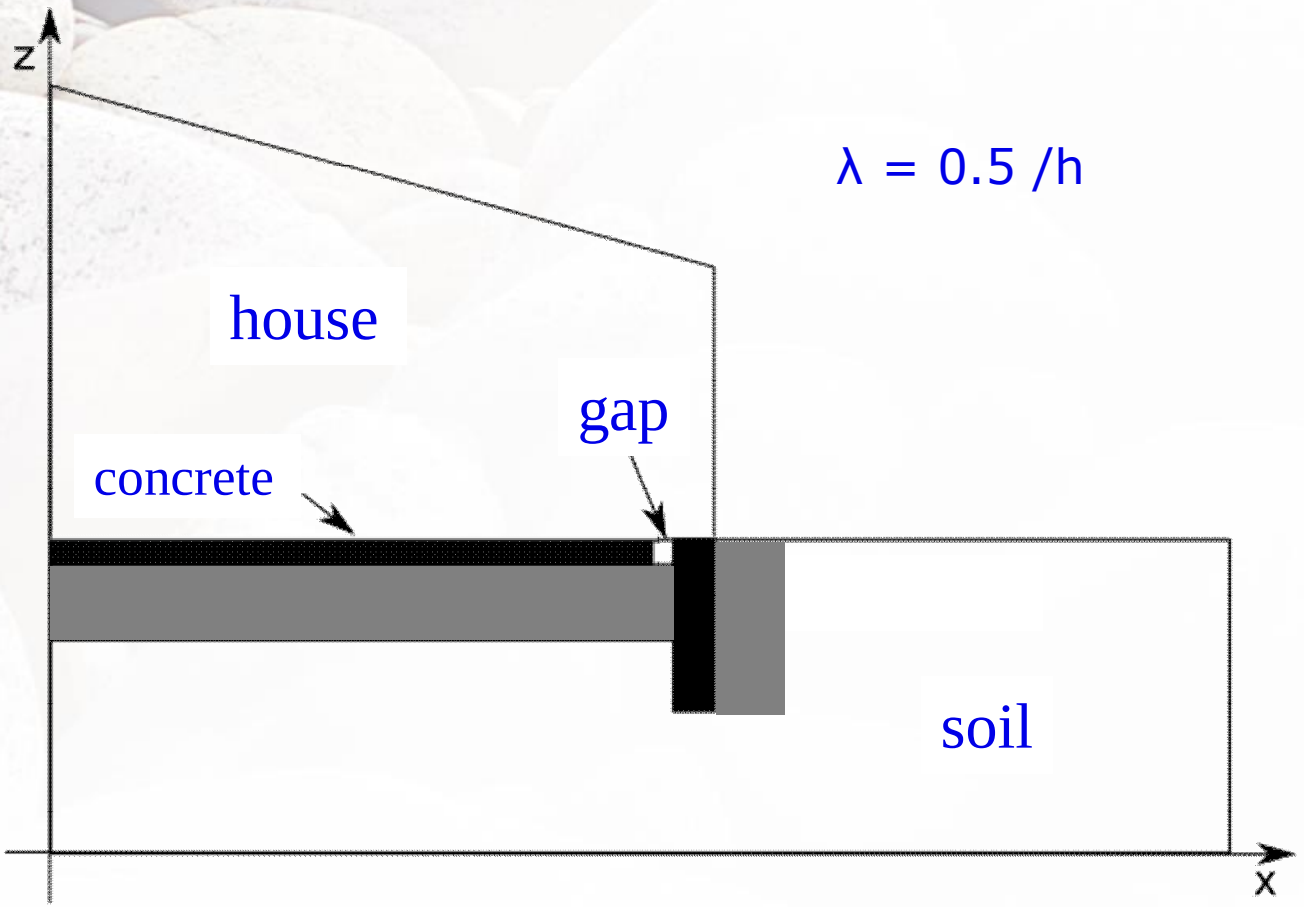
Åmodelling study to suggest contribution from gravel layer

Å**RnMod3** (Andersen, Risø lab – 2000, 2001)

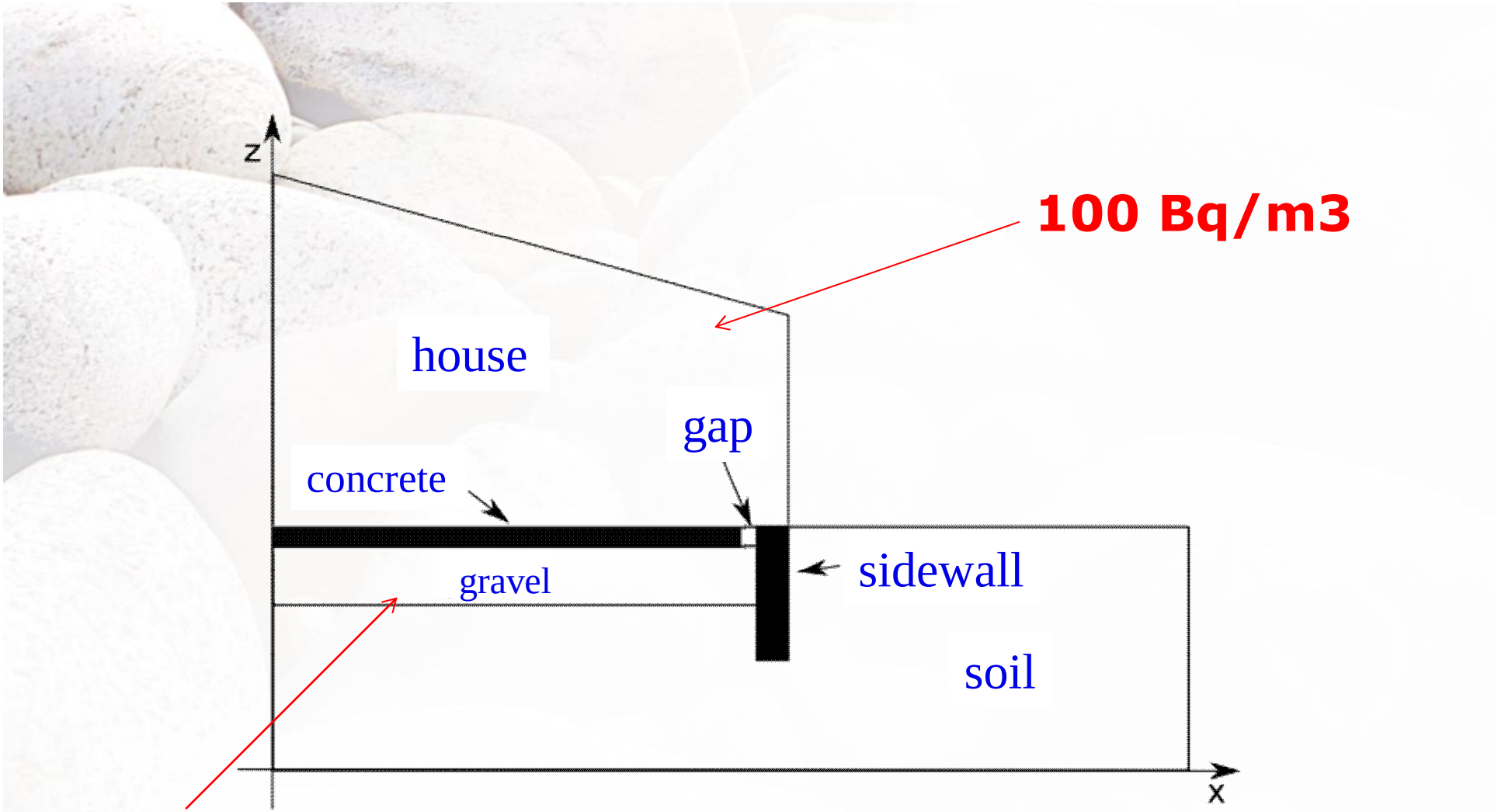
- Ågeometry
- Åmaterial / soil properties
- Åunderpressure

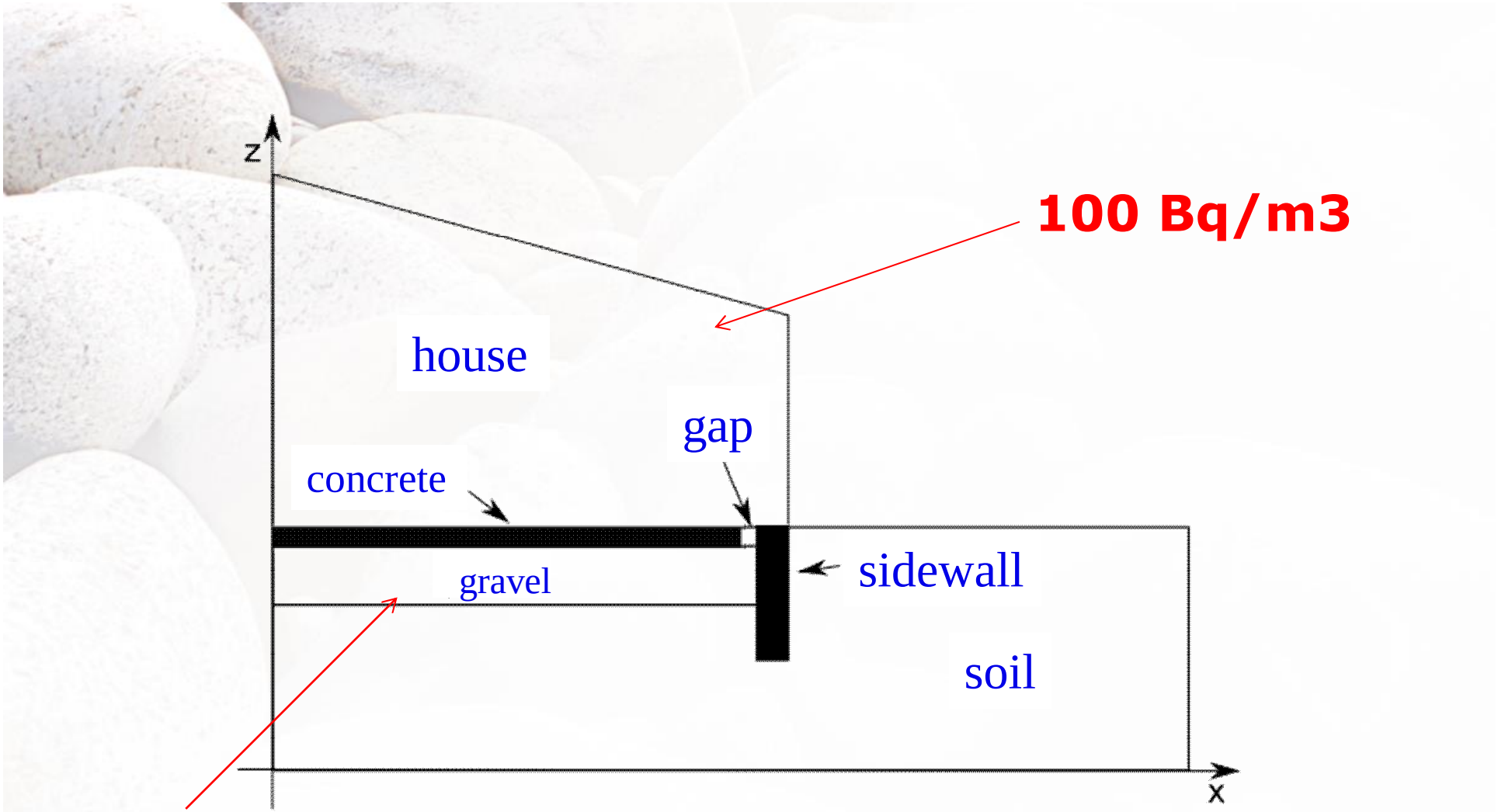

z
house
gap
concrete
gravel
sidewall
soil
x


z
house
gap
concrete
sidewall
soil
x


z
λ = 0.5 /h
house
gap
concrete
soil
x

Factors used in ”worst case”	
Gravel thickness	0,4 m
Fraction of emanation	0,4
Underpressure	3 Pa
Soil permeability	1×10^{-9} m^2


z
100 Bq/m3
house
gap
concrete
gravel
sidewall
soil
x
9.6 ppm U


z
100 Bq/m3
house
gap
concrete
gravel
sidewall
soil
x
9.6 ppm U

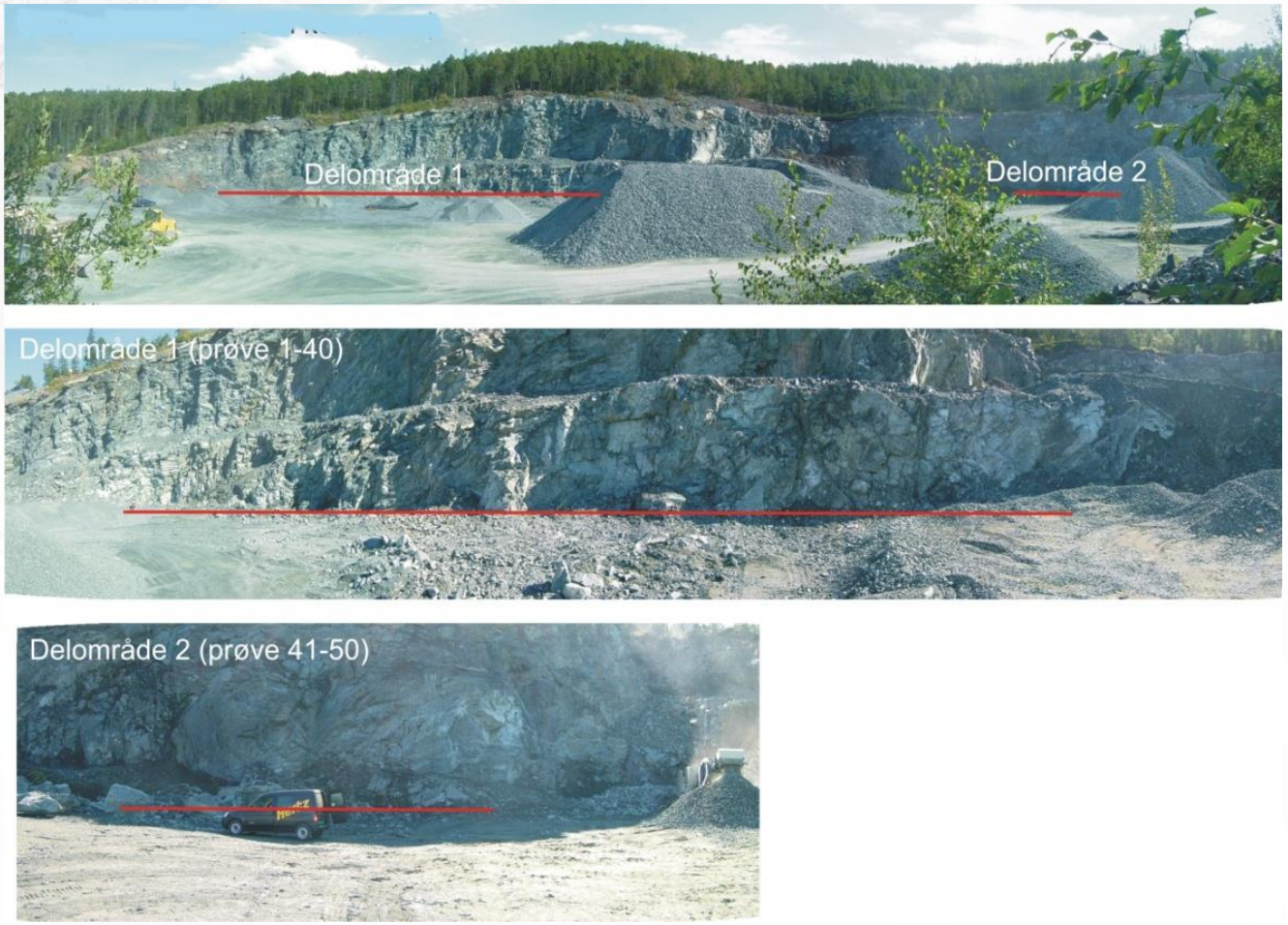
	Ra (Bq/kg)	U (ppm)
Halving of earlier Norwegian recommendation	150	12,15
”Worst case” in modelling	118	**9,6**

Minimum 20 samples per quarry

Main requirement (Sampling of quarry face)
1. Median ≤ **10 ppm** U
2. At least 90 % ≤ **12 ppm** U

Secondary requirement (Sampling of production material)
A. For deposits where all samples < 5ppm and geology is well described: no check of production
B. Production check every 3rd year if at least one sample > 5ppm
C. If any production samples > 12 ppm: new sampling of quarry face(s).

Recommended sampling procedure for industry



Deposit	No.	Median	Max	Main requirement	Approved?
Granite 1	40	6,8	29,0	Median OK, but too many samples > 12 ppm uran	No
Granite 2	38	11,2	23,0	Median too high.	No
Granite 3	40	16,6	38,7	Median too high	No
Amphibolite 4	20	1,0	13,7		Yes, but with subsequent production monitoring
Gabbro 5	11	0,1	0,1		Yes

Conclusions

- Recommend chemical sampling of material from quarries
- Sampling initially from quarry face
  - possible follow-up monitoring from production material
- At least 20 samples
- Median <= 10ppm
- No more than 10% of samples > 12 ppm
- Document for industry in preparation
- NGU report (in Norwegian) (NGU 2013.031)
- English article in preparation