Radiochemistry at the Environmental Monitoring Section at Institute for Energy Technology (IFE), Kjeller, Norway

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Radiochemical activities

- Environmental monitoring programme
  - Low-level liquid radioactive effluents
  - Environmental samples from the surroundings
- Personnel monitoring (bioassay)
- Research projects
- Commercial services


Kjellerholen
VA1
SD1
IFE
VA2
Utslippsledning
SD3
Nybrua
Lillestrøm
VA4
SD4
Rælingsbrua
VA5
SD5
FI6
BÅTHAVNA
Svelle
VA7
SD7
BP7
Glomma

Samples

- NALFA
  - Sediment (γ-emitters and Pu)
  - Water (γ-emitters, ^{3}H and ^{90}Sr)
- Rain water (γ-emitters, ^{3}H, ^{90}Sr and Pu)
- Farms
  - Milk (γ-emitters and ^{90}Sr)
  - Agricultural products (γ-emitters, ^{90}Sr and Pu)
- Gras (γ-emitters, ^{90}Sr and Pu)
- River
  - Water (γ-emitters, ^{3}H, ^{90}Sr and Pu)
  - Sediment (γ-emitters, ^{90}Sr, U and Pu)
  - Fish (γ-emitters,^{90}Sr and Pu)
  - Water plants (γ-emitters, ^{90}Sr and Pu)

U, Th, Pu, Am, Cm, Sr and Ra

- Pretreatment of samples (urine, discharge water, precipitation, river water, produced water, sediment, soil, biological material)
- Separation and determination of U, Th, Pu, Am, Cm, Sr and Ra


TRU (Pu(III), Am(III))
UTEVA (U(VI), Th(IV))
Sr(II)
Ra

Sr, U, Pu, Am and Cm in liquid effluents

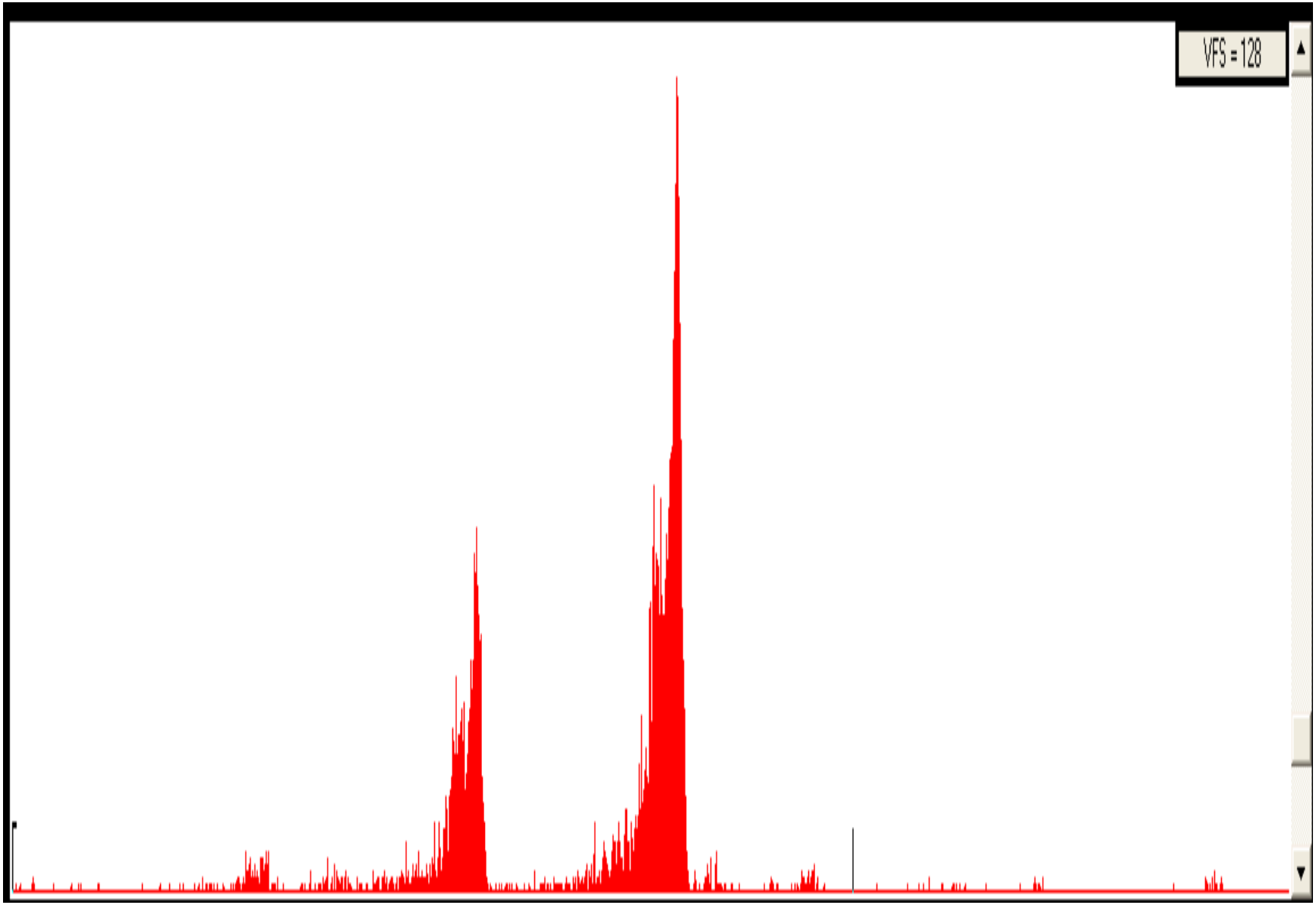
- 200 ml sample added tracers is evaporated and dry ashed
- Dissolved in 3 M HNO_3 added sulfamic acid, ascorbic acid and $Al(NO_3)_3$ (Fe(II), Pu(III))
- Loaded on UTEVA-TRU-Sr columns coupled together
- On-column oxidation of Pu(III) to Pu(IV) with $NaNO_2$
- UTEVA: U(VI) eluted with 0.01 M HCl
- TRU: Am(III) and Cm(III) eluted with 4 M HCl
  Pu(III) eluted with 4 M HCl + $TiCl_3$
- Sr: Sr eluted with 0.05 M HNO_3 (ingrowth of ^{90}Y)

Sr and Pu in sediment

- Drying and ashing
- Leaching with aqua regia
- Evaporation and dissolution in dilute HCl
- Oxalate precipitation followed by ashing
- Dissolution in 3 M HNO_3 added sulfamic acid, ascorbic acid and $Al(NO_3)_3$ (Fe(II), Pu(III))
- Loaded on TRU-Sr columns coupled together
- TRU: Pu(III/IV) (source prep.: co-precipitation)
- Sr: Sr

Sr, U, Pu and Am in urine

- Phosphate precipitation followed by ashing
- Dissolution in 3 M HNO_3 added sulfamic acid, ascorbic acid and $Al(NO_3)_3$ (Fe(II), Pu(III))
- Load on UTEVA-TRU-Sr columns coupled together
- UTEVA: U(VI)
- TRU: Pu(III/IV), Am(III), Cm(III)
- Sr: Sr


VFS = 128

^{210}Pb, ^{226}Ra and ^{228}Ra in produced water

- 2 litre produced water is heated with HNO_3 and MnO_4^- after addition of ^{133}Ba tracer
- pH adjustment to 1-2
- Reduction of MnO_4^- to MnO_2
- Addition of sulphate (H_2SO_4 and Na_2SO_4)
- Addition of Pb and Ba ($Pb(Ba)SO_4$)
- Collection of MnO_2 and $Pb(Ba)SO_4$
- Drying of the precipitate
- Gamma determination of ^{210}Pb, ^{226}Ra and ^{228}Ra

^{210}Pb and ^{210}Po in produced water

- Addition of ^{209}Po and stable lead
- Treatment of sample with acids and oxidizing agents
- Co-precipitation of Pb and Po with MnO_2
- Dissolution with HCl + H_2O_2
- Dissolve with 2 M HCl and load on Sr-Resin
- Wash with 2 M HCl and 6 M HNO_3
- Po: 6 M HNO_3
- Pb: 6 M HCl

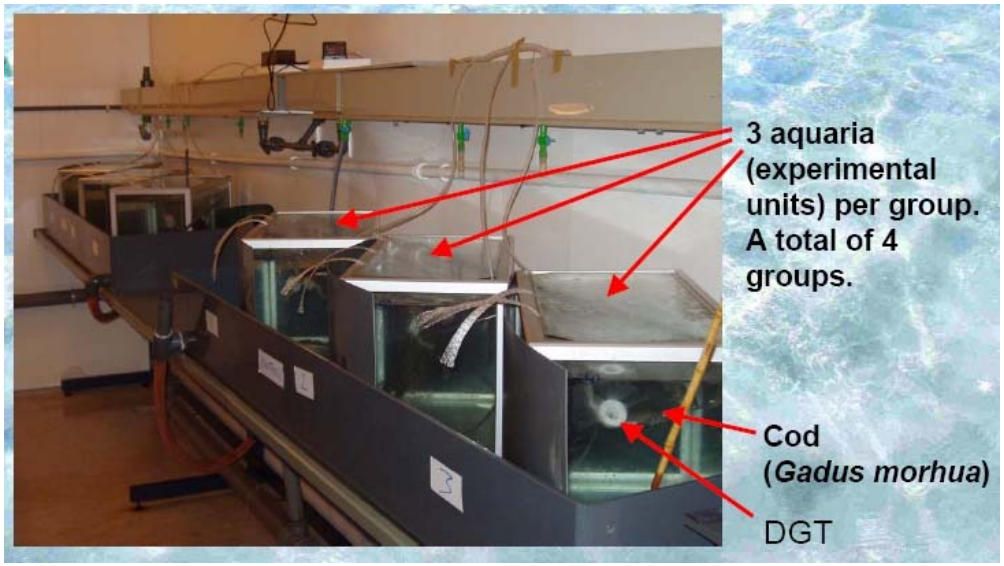
U, Th and Ra in Si materials

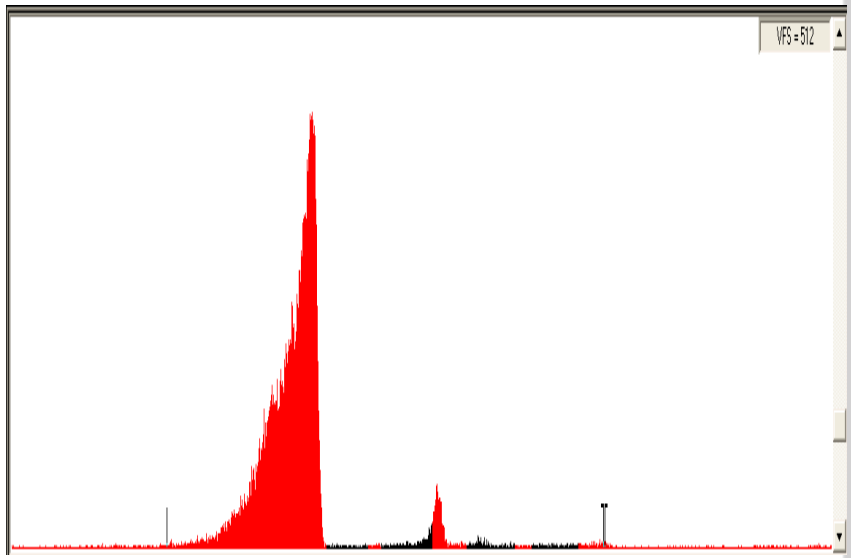
- Dissolution of Si-materials with HNO_3 – HF
- Treatment with HNO_3
- Dissolution in 3 M HNO_3
- Load on UTEVA
- UTEVA: Th(IV) eluted with 4 M HCl
  U(VI) eluted with 0.01 M HCl
- Ra sep. by sulfate precipitations
- Source prep.: co-precipitation

^{226}Ra and ^{228}Ra in seawater

- MnO_2 co-precipitation of Ra (pH 6-7!)
- Washing of the precipitate (wash out traces of Ca)
- Dissolution with HCl – H_2O_2
- $PbSO_4$ co-precipitation of Ra
- Dissolution with DTPA
- $BaSO_4$ co-precipitation of Ra $\rightarrow$ α-spec.
- Ingrowth of ^{228}Th from ^{228}Ra $\rightarrow$ Th separation and α-spec

^{226}Ra with DGTs





^{90}Sr in seawater

- ^{90}Sr co-precipitation with Ca(Sr)CO_3
- Sr separation from Ca by repeated nitrate precipitations
- Sr separation from Y by repeated hydroxide precipitations
- Sr separation from Ba, Ra and Pb by repeated chromate precipitations
- Ingrowth of ^{90}Y
- ^{90}Y separation from ^{90}Sr by hydroxide and sulphate precipitations

^{90}Sr in seawater – new

- Acidification and equilibrium between ^{90}Sr and ^{90}Y
- Co-precipitation of Y carrier and ^{90}Y with $Fe(OH)_3$
- Dissolution and evaporation
- Y extraction with TBP from 14 m HNO_3
- Y strip with H_2O
- Is further separation from Th required? Phosphate precipitation of Th?
- Source preparation by hydroxide and oxalate precipitation
- Risø beta counter and EDTA titration

Thanks!