

**Trace Element Analysis
of Geological, Biological &
Environmental Materials
By Neutron Activation Analysis:
An Exposure**

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Session 2

- **Review of some concepts from Session 1**
- **Gamma Detection – Instrumentation Concepts**
- **Neutron Activation Analysis – Applications: Trace Element Analysis of Geological, Biological, Environmental and Industrial Materials**
- **Presentation and report assignment (one per student): Epithermal, Delayed Neutron, Prompt Gamma Neutron Activation Analysis Essay (Report)**



Neutron Activation Analysis – Applications:

Trace Element Analysis of Geological, Biological and Environmental Materials



Applications:

1. Fluorine in cloth used in furniture industry.

$^{19}\text{F}(n,\gamma)^{20}\text{F}$ (1.63 MeV; 11.56 s T_{1/2}) about
1000 ppm

2. Fluorine in petroleum refining industry.

Petroleum companies use refining techniques which using HF, in which F should not exceed
0.01 ppm



Applications: ...

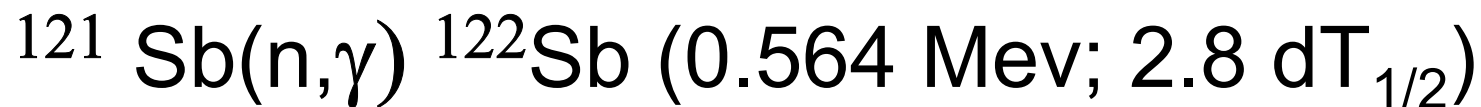
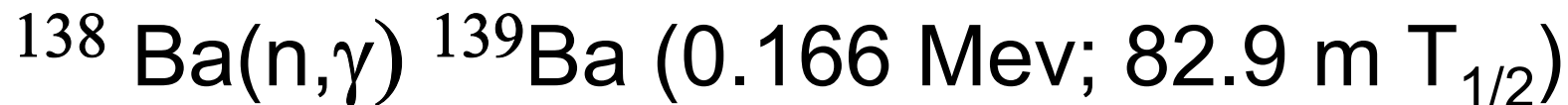
3. Vanadium in crude oil:

$^{51}\text{V}(n,\gamma)^{52}\text{V}$ (1.434 Mev; 4 m T_{1/2})

1 ppm to 0.1 ppb

Applications: ...

4. Ba and Sb in forensic investigation.
Determination of Ba and Sb in gunshot residues involves chemistry to dissolve samples lifted off the scene with paraffin wax.



Also, a radioactive tracer is used.



Applications: ...

5. Sb in bullet manufacturing.

0.3% to 4% Sb is used to harden the bullets.

Measurement of Sb in bullets in crime,
identifies the manufacturer.



Applications: ...

6. Trace element content in hair material:
Useful to characterize a person in forensic
Identification.

7. Na content in fingernails:
Helps in early diagnosis of cystic fibrosis in
Children.





Applications: ...

8. Trace element contents in blood:

10 major elements of a human

O, C, H, N, Ca, O, K, S, Na, Cl.

2 essential trace elements : Mg, Fe

7 known essential sub trace elements:

Zn, Cu, Mn, Mo, I, Co, Sc

.....

Applications: ...

9. Bromine content in food stuffs

CH_3Br is a pesticide. Br is a pesticide residue.

^{81}Br (n, γ) ^{82}Br (0.554MeV;35.34 h T1/2)

0.1 ppm to 10 ppm

10. Mercury content in food stuff.

Mercury is a toxic element in food stuff, with designated zero-tolerance.

^{196}Hg (n, γ) ^{197}Hg (77.6 keV; 65h T1/2)

0.05 ppm



Applications: ...

11. Coding Elements In many areas of interest, like counterfeiting, crime investigation, etc., there is a need to identify unambiguously but subtly. Determine base level – and then add a coding element.



Applications: ...

12. Trace element geochemistry of rocks, minerals and ores – Earth Sciences

13. Trace element environmental geochemistry – Environmental Sciences



Neutron Activation Analysis

- Thermal
- Epithermal
- Fast
- Prompt Gamma
- Delayed Neutron
- Instrumental Neutron Activation Analysis (INAA)
- Radiochemical Neutron Activation Analysis (RNAA)



Reference

The current status of neutron activation analysis applications, pages 679-697,
V. P. Guinn,
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National Bureau of Standards Special Publication 312, Volume II, 1969



Further References

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- International Conference on Modern Trends in Activation Analysis (5th : 1976 : Munich)
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- International Conference on Modern Trends in Activation Analysis (1972 : Centre d'Études nucléaires, Saclay, France)
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- International Conference on Modern Trends in Activation Analysis (1968 : National Bureau of Standards)
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Washington, U.S. National Bureau of Standards; for sale by the Supt. of Docs., U.S. Print. Off., 1969.



Further References

- Methods and Applications of Radioanalytical Chemistry – MARC series

The MARC conference series' most recent conference was MARC VI held in 2003 held in Kailua-Kona. Previous conferences were held in 1987, 1991, 1994, 1997, and 2000 respectively.

- Marc VI

http://www.min.uc.edu/nuclear/marc/pdf/contents_v01_marcvi.pdf



Course Assignment

- Do literature survey, write a report and present in the class.
- Outline
 - Introduction
 - Principles
 - Instrumentation (Methodology)
 - Application
 - Provide references (text books, journals, ...)



Session 2 End