



CENTRE FOR ENERGY RESEARCH AND TRAINING
(Nigeria Atomic Energy Commission)
AHMADU BELLO UNIVERSITY ZARIA NIGERIA



THE USE OF Am-Be SOURCE FOR TEACHING & APPLIED RESEARCH

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PRESENTATION OUTLINE



- ★ BACKGROUND/INTRODUCTION
- ★ THE 1 Ci Am-Be based TNRT FACILITY AT CERT
- ★ THE 5 CI AM-Be based NAA FACILITY AT CERT
- ★ ACHIVEMENTS WITH THESE FACILITIES
- ★ SUMMARY, CONCLUSIONS & NEXT STEPS
- ★ REFERENCES

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INTRODUCTION



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- Since its discovery, neutron has been used as a valuable tool for exploring the structure of the nucleus
- Very powerful analytical methods based on neutron interactions with matter have been developed for the determination of elements & isotopes - NAA.
- In many developing countries especially in Africa, the application of nuclear analytical methods, especially, NAA for material research has not gained the needed acceptance
- Due to lack of neutron sources, associated equipment & expertise, especially Research Reactors (RRs)

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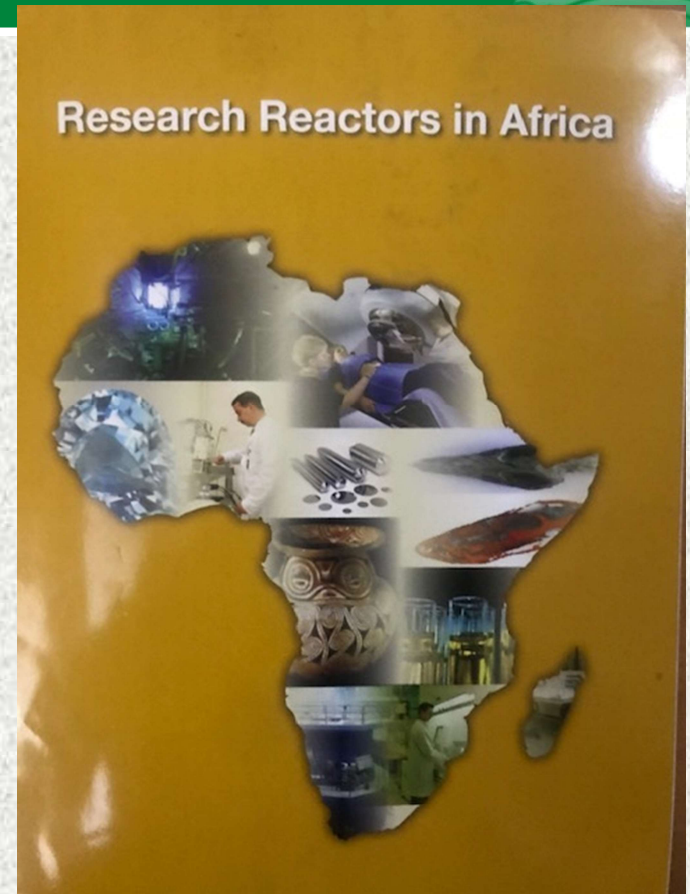


INTRODUCTION



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- RRs are the most appropriate neutron sources for NAA
- Only 8 African countries have RRs: Algeria (2); DR Congo (2); Egypt (2); Ghana (1); Libya (1); Morocco (1); Nigeria (1) & S/Africa (1), a total of 11 out over 400 in the world
- To assist developing MSs, the IAEA (1988) developed a manual on the use of isotopic neutron sources (INS) for NAA.
- INS are economic, simple & safe to use in Teaching & Research





CERT's Am-Be NEUTRON SOURCES



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- At the Centre for Energy Research and Training (CERT), a 1 Ci & 5 Ci Am-Be neutron sources were installed for teaching and applied research since 1992.
- Because of the diversification of the Nigerian economy from oil to non-oil sector, the facilities have been found to be useful for the quantification of some industrial minerals
- The applications of the 2 neutron sources via NAA and neutron reflection techniques for the quantification of industrial raw materials and energy minerals such as crude-oil and coal are discussed

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THE THERMAL NEUTRON REFLECTION TECHNIQUE (TNRT)



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- The thermal neutron reflection technique was developed by Buczko et al., (1975) for the determination of bitumen content of asphalt concrete.
- Other workers have used it for various other applications (Al-jobori et al., 1978; Szegedi et al., 1982; Chimoye, 1991; Obi and Jonah, 1999; Csikai and Buczko, 1999; Kiraly and Csikai, 2000); Jonah et al., 1997, 1999, 2003, 2004).

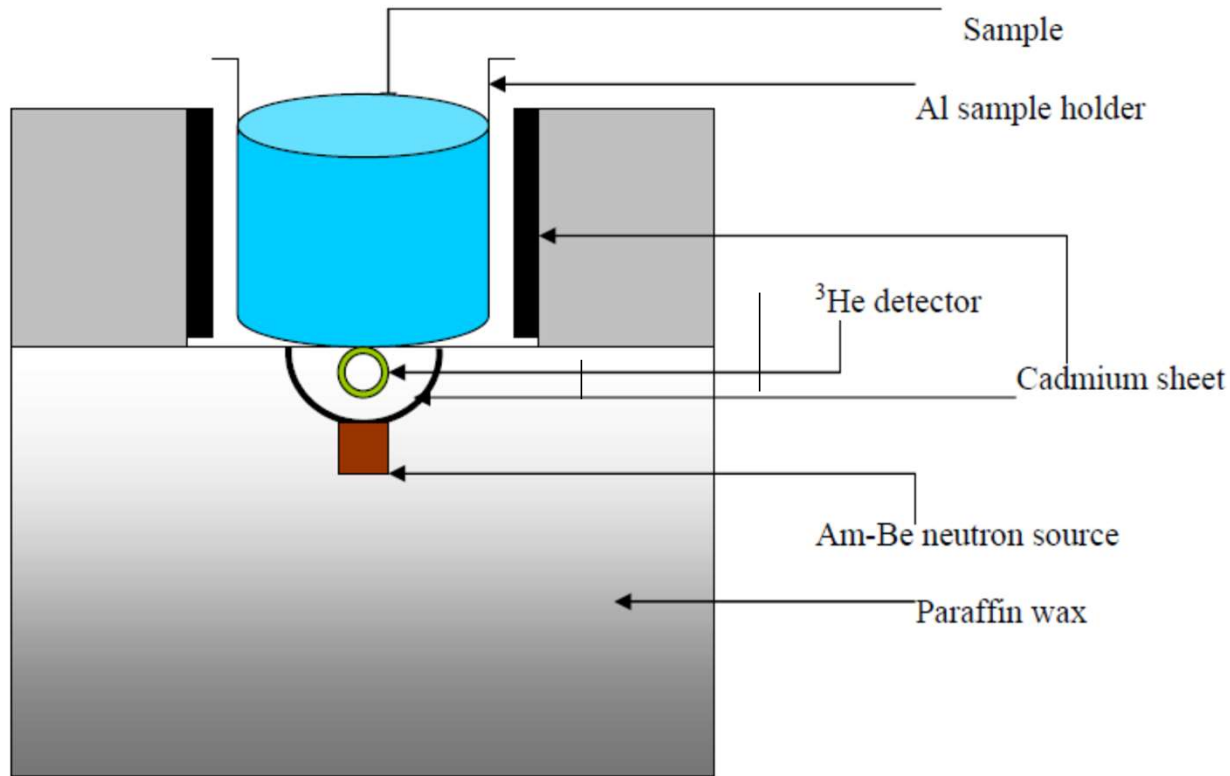
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THE THERMAL NEUTRON REFLECTION TECHNIQUE (TNRT)



Am-Be neutron source



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THE THERMAL NEUTRON REFLECTION TECHNIQUE (TNRT)

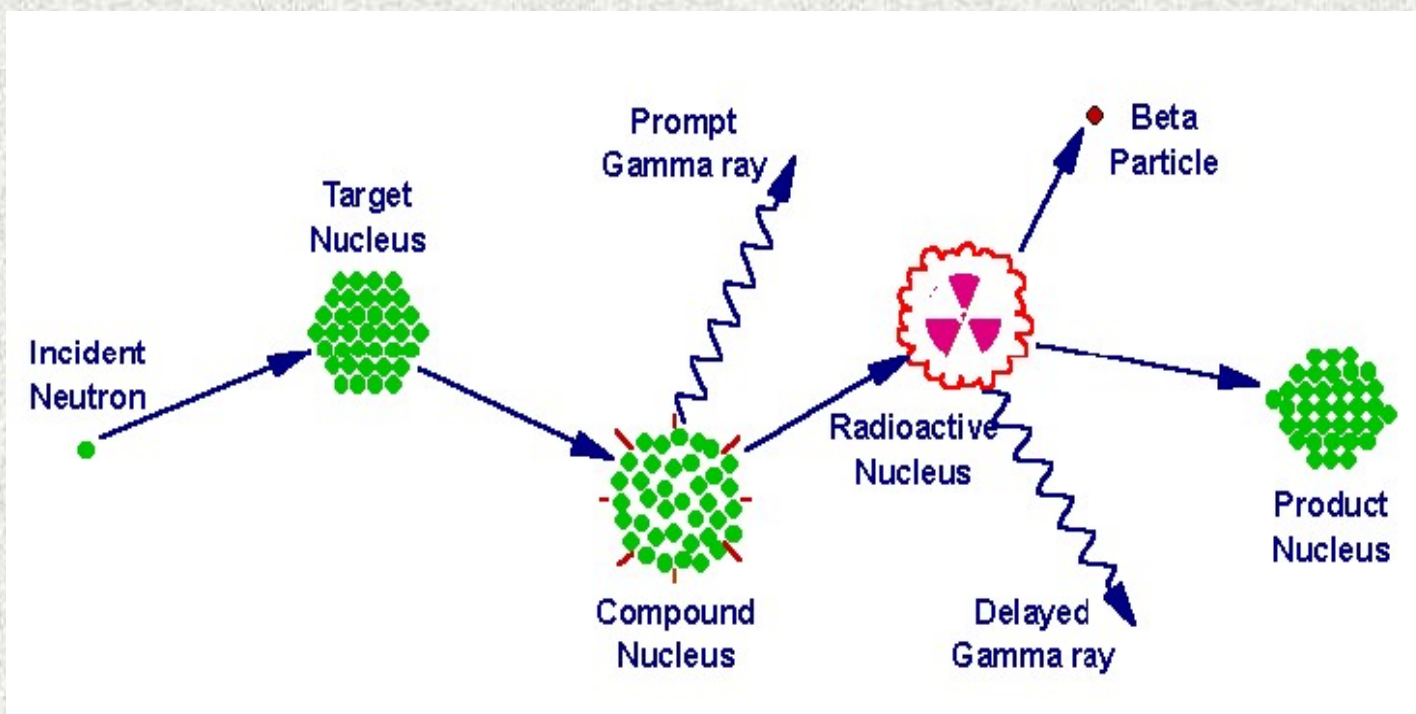


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- The principle of the method is based on the fact that the energy loss by fast neutrons through interaction with the atoms of a medium strongly depends on the mass number of the colliding partners
- Consequently hydrogen, which has a mass number of one dominates in the slowing-down of fast neutrons.
- For this reason, when a sample is exposed to a beam of fast neutrons, the correlation between the intensity of reflected thermal neutrons and the hydrogen atoms in the sample can be used to determine the total H content in it.

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BASIC THEORY OF NUCLEAR REACTION-NAA



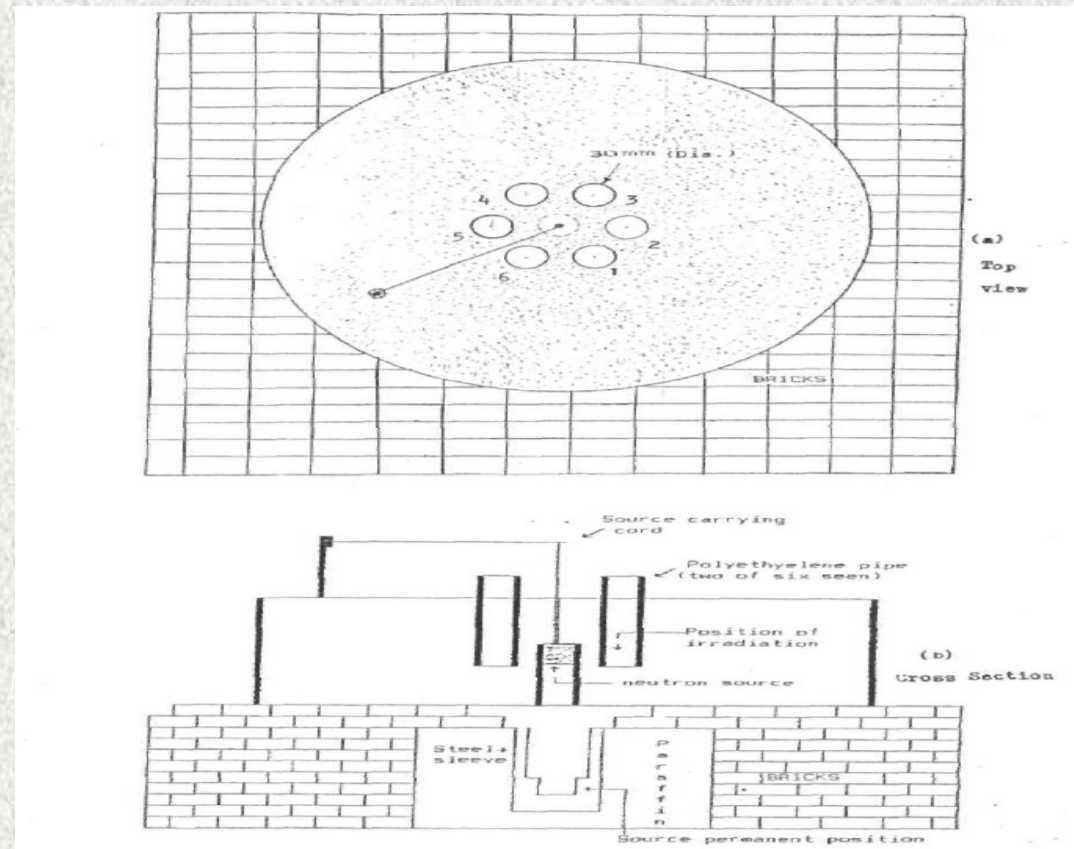


NEUTRON ACTIVATION ANALYSIS WITH THE 5 Ci Am-Be SOURCE



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NAA setup
At CERT



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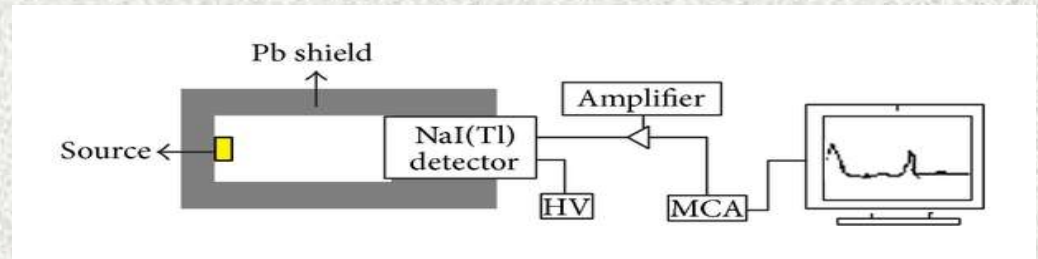


NEUTRON ACTIVATION ANALYSIS WITH THE 5 Ci Am-Be SOURCE



- Polyethene bags
- Cotton wool
- Sample holder
- Strings
- Personal Computer
- Masking tapes and stop watch

- Digital weighing balance
- Samples and Standards
- Crushing machine
- Activation foils
- Calibration point sources set
- Plastic vials



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STUDENTS' WORKS PERFORMED - TNRT



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- N. C. Onuoha "Determination of total H content of oil samples using neutron transmission technique" A **completed** B. Sc. Physics Thesis, Department of Physics, Ahmadu Bello University, Zaria, Nigeria (1998)
- N. F. Isa "Applications of neutron scattering, absorption and thermalization in the evaluation of energy minerals". A **completed** Ph. D. project, Department of Physics, Ahmadu Bello University, Zaria, 2002
- Akpan K.F "Quality control of lubricants using neutron reflection technique" A **Completed** M. Sc., Department of Physics, Nigerian Defence Academy, Kaduna, Nigeria, 2010

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STUDENTS' WORKS PERFORMED - TNRT



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- M.N. Okaba Determination of the working voltage, threshold discrimination and active length of He-3 neutron detector at CERT, Zaria, B. Sc Project, Department of Physics, Ahmadu Bello University, Zaria, Nigeria (2015)
- Jibril A. “Application of TNRT for detection of Narcotics and Explosives”. **An Ongoing M. Sc.**, Department of Physics, Ahmadu Bello University, Zaria, 2022

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MAJOR R & D WORKS PERFORMED – NAA



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Determination of the Selected Major Elements in their Ores

- Samples (Al, Si, Mn, Fe, Ta, Au and Zn ores)
- Samples are irradiated bare and inside Cd cover with using the Am-Be source facility, and counted on the NaI (TI) detector.
- The nuclear reactions involved in the determination of these major elements by TNAA in their ores are: $^{27}\text{Al} (n, \gamma) ^{28}\text{Al}$, $^{28}\text{Si} (n, p) ^{28}\text{Al}$, $^{55}\text{Mn} (n, \gamma) ^{56}\text{Mn}$, $^{56}\text{Fe} (n, p) ^{56}\text{Mn}$, $^{181}\text{Ta} (n, \gamma) ^{182\text{m}}\text{Ta}$, $^{197}\text{Au} (n, \gamma) ^{198}\text{Au}$ and $^{115}\text{In} (n, \gamma) ^{116\text{m}}\text{In}$ for Al, Si, Mn, Fe, Ta, Au and In respectively.
- The nuclear reactions involved by FNAA are: $^{27}\text{Al} (n, p) ^{27}\text{Mg}$, $^{28}\text{Si} (n, p) ^{28}\text{Al}$, $^{55}\text{Mn} (n, n) ^{55}\text{Cr}$, $^{56}\text{Fe} (n, n) ^{56}\text{Mn}$, $^{181}\text{Ta} (n, n) ^{181}\text{Hf}$, $^{197}\text{Au} (n, n) ^{197\text{D}}\text{t}$

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SUMMARY, CONCLUSION, NEXT STEPS



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- Only few facilities for teaching & research in African countries due to cost of installing RRs
- Only 8 African countries own 11 RRs in the Region
- IAEA has encouraged the use of INS for teaching & research
- INSs are economic, simple and safe to install in Universities for teaching & research
- CERT, ABU Zaria has installed a 1 Ci Am-Be source for use via the Thermal Neutron Reflection Technique for analysis of H in oil samples
- In the same vein, a 5 Ci Am-Be neutron has been used to develop a simple NAA facility for elemental analysis of major elements in their ores, such as AL in Bauxite etc.
- These facilities are recommended for countries without RRs to help in E & T so that they develop the needed manpower in NS & T
- We are prepared to assist in this respect

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- ❑ **IAEA_TEC-DOC**, Isotopic Neutron Sources for NAA. User's Manual IAEA-TEC-DOC 465 IAEA, Vienna Austria(1988)
- ❑ **S.A. Jonah**, A.M. El-Megrab, M. Varadi and J. Csikai, 'an improved neutron reflection setup for the determination of H and (O+C)/H ratio in oil samples' J. of Radioanal. & Nucl. Chem., 218, (1997), 193
- ❑ **S.A. Jonah**, I.I. Zakari and S.B. Elegba 'Determination of the hydrogen content of oil samples from Nigeria with an Am-Be neutron source' Appl. Rad. & Isot., 50, (1999), 981-983.
- ❑ A. I. Obi, **S.A. Jonah**, 'Determination of the hydrogen content in Nigeria palm oil by the neutron moderation method' J. of Radioanal. & Nucl. Chem., 242, (1999), 531-532

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- **Jonah, S. A.**, Oladipo, M. O. A., Umar, I. M., Rabi, N., Idris, Y. U. I. and Zakari, Y. (2004) A Quick for the Determination of the Al/Si Weight Ratio in Alumino-silicates Using an Am-Be Neutron Source. *Journal of Radioanalytical and Nuclear Chemistry*. Vol. 262, No. 2, pp. 501-504.
- Nasiru, R. (2005). The Standardization of the Am-Be Neutron Source for Application in k_0 -NAA Method. An unpublished PhD thesis submitted to the postgraduate school, Ahmadu Bello University, Zaria.



END OF PRESENTATION



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Thank you for listening