

IN-SITU ELEMENTAL ANALYSIS AND PROVENANCE STUDY OF TERENGGANU'S HISTORIC STONE USING NEUTRON INDUCED PROMPT GAMMA-RAY TECHNIQUES

Tuesday, 10 September 2013 16:30 (20 minutes)

Batu Bersurat Terengganu (Terengganu's inscribed stone) is the oldest artifact with Jawi writing on it. The artifact proves that the Kingdom of Terengganu exist earlier than 1326 or 1386. It was accidentally discovered near Tersat River at Kampong Buluh, Kuala Berang, Terengganu, Malaysia by a gold & tin trader after a flash flood hit Kuala Berang. He was then presented the stone to the sultan (Zainal Abidin III). The sultan had it placed in the fort on Bukit Puteri, and there it remained until 1922 when a British colonial official had it sent to the Raffles Museum in Singapore for examination. The inscription turned out to be a proclamation issued by the "Sri Paduka Tuan" of Terengganu. The significant is the date on the first face of the inscription, which is given as the year 1303 AD.

The stone itself is still shrouded in historical mysteries. What happened to the first kingdom of Terengganu? What indeed was its origin and why did this kingdom subsequently disappear? Was the inscribed stone made of stone from local deposit? And if the stone was made locally, where was it made on the Terengganu site? There is no scientific data or reports available in opened literatures up to now. It is a most treasured heritage.

Due to invaluable historical values, at the UNESCO International Advisory Committee meeting in Barbados on 13 July 2009, the 700-year-old inscribed stone was listed as an item eligible for world heritage recognition. A lot of methods is being developed by scientists, archaeologists and historians to study different aspects of the inscribed stone. The first scientific project is to develop a non-intrusive analytical inspection based on nuclear techniques. Conventional neutron activation analysis (NAA) is a well established nuclear technique, which may be used to investigate elemental composition of materials. However, a sample needs to be taken before irradiating with neutrons in nuclear reactors. Due to high historical values of Terengganu's inscribed stone, taking samples from it is restricted by the Terengganu State Museum Authority. X-ray fluorescence (XRF) method using a portable system is another choice but it is limited to the surface analysis. Neutron induced prompt gamma-ray technique (NIPGAT) using isotopic neutron source in conjunction with portable gamma-ray spectroscopy system can be applied to studies a large variety of samples. Indeed, it may be used to address the above-mentioned questions in non-destructive manner. Neutrons are useful as probes for non-destructive examination of extended media because neutrons can travel relatively long distances before interacting with the nuclei of the media. It is for this reason that NIPGAT is being developed at the Malaysian Nuclear Agency for in-situ quantitative elemental analysis and finally for provenance study of the Terengganu's inscribed stone.

This paper describes the experimental set-up and presents some of the results of NIPGAT obtained from many samples from two types of stones, namely Dolerite and Granite which are most likely the river boulders used for making the inscribed stone. The MCNP code developed by Los Alamos Laboratory was also used to design and optimise the laboratory and field experimental facilities. Based on these results a portable system based on neutron-induced prompt gamma-ray techniques was constructed. Using this system, the inscribed stone can be investigated in a volumetric manner and non-destructively thus increasing measurement accuracy. The scientific data or technical evidence obtained from this project will be of great benefits not only to curators and archaeologists but also to scientists, historians and many others.

Primary author: Dr ABDULLAH, Jaafar (Malaysian Nuclear Agency)

Presenter: Dr ABDULLAH, Jaafar (Malaysian Nuclear Agency)

Session Classification: Prompt Gamma Activation Analysis I

Track Classification: NINMACH