Neutron Activation Analysis (INAA) of Archaeological Materials

Archaeologists employ a variety of analytical techniques to study prehistoric cultural materials. Many of these methods are experimental, have limited applicability, or are extremely expensive. After four decades of research and application to archaeological investigations, instrumental neutron activation analysis (INAA) continues to be the most accurate, precise, and sensitive technique for analyzing the elemental composition of archaeological samples. Cultural resource management (CRM) firms and government agencies are beginning to recognize that INAA characterizations of cultural materials can help to maximize the information yield for projects of almost any size. Fifteen years of support for academic research have given us the experience and comparative data bases necessary to offer INAA-based source determinations on a commercial basis. This brochure summarizes INAA, gives a few of the examples in which INAA has worked to improve archaeological understanding, and answers some of the most frequently asked questions about incorporating INAA into contract archaeology projects.

What is INAA?

Instrumental neutron activation analysis is an established method for compositional analysis of archaeological materials that offers great precision and sensitivity. In INAA, the sample is first bombarded with neutrons, thus making elements in the sample radioactive. The samples then are placed in front of a germanium detector to measure the energies and number of gamma rays emitted when the radioactive elements decay. Because each element emits gamma rays at characteristic energies, measurements of the gamma rays can be converted to amounts of elements in the sample. At MURR, up to 33 elements are analyzed in each sample with many sensitivities below the ppm level.

What can INAA do for CRM archaeological projects?

Provenance studies can be an important component of any CRM- or academic-based archaeological research project. By comparing the elemental profiles of artifacts to those of source samples, either provided by the researcher or already in our database, the origins of artifacts often can be determined. Even when archaeological samples cannot be conclusively sourced, important information often results. For example, when pottery samples are characterized, differentiation into local vs. nonlocal provenance may be possible or compositional subgroups may be correlated with specific pottery types.

How many samples should be submitted?

Any number of samples can be submitted. In areas where source materials are well characterized, even a single INAA sample can provide meaningful information. Based on the completeness of our database in your project area, we can advise you on the number of samples to submit in order to maximize your chances of obtaining useful results.
Examples of Recent CRM Projects Using INAA

Pottery. Ten pottery samples from a Titus-phase (A.D. 1430-1680) Caddoan cemetery in northeastern Texas were analyzed by INAA at MURR. This cemetery, known as the Mockingbird site, was investigated as part of a contract mitigation and NRHP eligibility-determination project (Rogers 1998). The pottery was compared to samples also analyzed at MURR from the Hurricane Hill site, 60 km west of Mockingbird (Perttula 1997), and to regional samples analyzed by Steponaitis et al. (1996). Hurricane Hill pottery formed two compositional groups (Figure 1). One group, Hurricane 1, was determined to be a local group. The other group, Hurricane 2, had affiliation to nonlocal samples from the Red River/Great Bend area in southwestern Arkansas. Compositional analysis showed that the Mockingbird samples, even though originating from five pottery types, formed a single locally produced compositional group that was affiliated with the Hurricane 1 samples. In this project, despite the lack of clay source samples, production areas for the pottery were determined, in part because of MURR’s collaboration with other laboratories.

Obsidian. The Coso obsidian field is known to have been one of the most heavily utilized prehistoric sources of obsidian in California; artifacts from this field have been recovered from the San Diego area to the San Francisco Bay. Obsidian source samples from fifteen locations in the Coso field were submitted to MURR for INAA. Previous studies using X-Ray fluorescence (XRF) identified four chemically different obsidian groups in the field. However, by using INAA, our Laboratory identified six compositional groups (Figure 2). X-Ray fluorescence has been the most common method for sourcing obsidian in the western and southwestern United States. The primary advantage of XRF is low cost (approximately $35/sample). The advantages of INAA are higher sensitivity, more elements, and the ability to analyze small samples (NAA is possible on 5-10 mg samples). Combined, these advantages facilitate differentiation of compositionally similar obsidians. This study shows that the higher resolution of INAA provides better obsidian sourcing than does XRF, and at a comparable price.

Chert. Chert was widely used by prehistoric peoples to manufacture stone tools. In contrast to obsidian and pottery, chert has proven to be more difficult to source by most analytical techniques, including INAA. Within-source variation in a chert deposit for many, if not most, elements often is as great as between-source variation. The success achieved at MURR in the source analysis of chert is due to the large number of elements determined (approximately 30) and the excellent precision (± 2–6%) for most elements. For example, eight samples of six chert blades from Mt. Vernon mound (12P0885) and 33 source samples from four midwestern U.S. formations were submitted to MURR for INAA. This site has figured prominently in ARPA and NAGPRA enforcement (Beard 1997; Munson et al. 1995). Compositional analysis indicated that the chert artifacts came from a diversity of sources (Figure 3): Three blades came from two Indiana sources, two blades came from Ohio, and one blade came from Missouri. Thus, INAA provided crucial information about the Mt. Vernon artifacts prior to reburial.

References
INAA An Important Tool for Contract Archaeology Projects

The Archaeometry Laboratory at MURR was formally established in 1988 following a laboratory-support grant from the National Science Foundation. MURR is arguably the world leader in processing INAA samples for archaeology—approximately 5,000 per year. Compositional data for more than 50,000 samples (over 20,000 from the United States) are stored in our data bank, including ceramics (Figure 4), obsidian (Figure 5), chert (Figure 6), related source samples, and lesser amounts of other materials, such as marble and basalt. The Archaeometry Laboratory also has developed data base intercalibrations with INAA programs at Brookhaven National Laboratory, National Institute for Science and Technology (NIST), Lawrence Berkeley National Laboratory, Hebrew University, and the British Museum. When merged with data from these other laboratories, the overall compositional data bank of approximately 100,000 analyses is an outstanding reference for archaeological research. We are working on intercalibrations with other techniques that will further enhance our ability to exchange data. The combination of these data bases with rigorous multivariate statistical methods allows the sources of many archaeological materials to be determined with a high degree of confidence.

Research Staff:

Dr. Michael D. Glascock (Ph.D. 1975) is a Senior Research Scientist and Group Leader of the Archaeometry Laboratory. He has been with MURR since 1979 and is the originator of the MURR Archaeometry Laboratory. He has over 20 years of experience with INAA and gamma-ray spectroscopy as applied to archaeology, geochemistry, and environmental science. His current research focus involves refining obsidian sourcing and artifact characterization in the western United States.

Mr. Jeff Speakman (M.A. 2002) is a Senior Research Specialist in the Archaeometry Lab. He joined MURR in 1997. His research interests include quantitative research methods, North American archaeology, ceramic and lithic technology, inductively coupled plasma mass spectrometry (ICP-MS), and has ongoing projects in a number of regions of North America.

Glascock and Speakman maintain collaboration with Dr. Hector Neff. After twelve years, Neff left MURR to assume a tenure track position at Cal State Long Beach. His research interests include quantitative methods of provenance determination, and he has ongoing projects in a number of regions of Mesoamerica and North America.

Glascock and Speakman are assisted by three graduate and three undergraduate students. Dr. Leslie Cecil (Ph.D. 2001, SIU) currently holds the Post Doc position at the MURR Archaeometry Lab.
How much does INAA cost?
See the table at right for our fees. Contact us about charges for other sample types or special processing. Purchase orders should accompany samples.

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<th>Sample</th>
<th>1-50</th>
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<tr>
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Charge Schedule for INAA
(Prices effective Aug 1, 2002)

How long will INAA take?
CRM samples will have first priority in all phases of our procedures. The complete turnaround time usually ranges from three to six months. Obsidian sourcing may be possible in considerably shorter time.

Can I have my samples back after the analysis is completed?
Yes. We will return the unused portions of all samples to you, if you make certain to so indicate on correspondence accompanying the samples. Sample portions used for neutron irradiation cannot be returned. We retain a small archival piece of pottery for our reference collection of paste samples.

Summary of Advantages to Incorporating INAA in CRM Proposals and Projects:

—INAA is an established procedure with a long history of providing accurate information on the sources of archaeological materials.

—INAA-based source determinations enhance the quality and thoroughness of archaeological analysis, enhance the overall quality of contract reports, and can support evaluation of sites for further investigation and/or determinations of NRHP significance.

—INAA is a time- and cost-effective procedure. In addition to the raw data, a report on the analysis and its archaeological implications is provided at no extra charge.

What about my other questions? How do I contact the Archaeometry Lab?
Visit our website at www.missouri.edu/~glascock/archlab.htm, or contact either Dr. Michael D. Glascock (lithics) or Mr. Jeff Speakman (ceramics) to discuss any questions not answered in this brochure. Do not send any samples without discussing your project with one of us! Phone numbers and e-mail addresses are as follows: Dr. Michael D. Glascock phone: (573) 882-5270 e-mail: GlascockM@missouri.edu; Mr. Jeff Speakman: (573)882-5241 e-mail: SpeakmanR@missouri.edu. Fax: (573) 882-6360

Michael D. Glascock/ Jeff Speakman
Archaeometry Laboratory
Research Reactor Center
Research Park
Columbia, MO 65211