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Commentary on: Elemental Analysis of Human Cremains Using ICP-OES to Classify Legitimate and Contaminated Cremains. J Forensic Sci 2006;51(5):967–73.

Sir:

The authors of this study performed careful analysis by inductively coupled plasma-optical emission spectroscopy (ICP-OES), followed by variable cluster and principal component statistical analysis on the resulting data to distinguish between mixtures of concrete and cremains. The ICP analysis consisted of dissolution of samples followed by measurement of concentration of a suite of 21 elements, seven of which were subsequently removed from the study for various stated reasons.

When faced with the challenge of determination of the integrity of urn contents, the forensic analyst has to select the most appropriate technique from the choices available. In technique selection, rapidity of analysis together with cost and access should be considered, especially in the light of the workload placed on crime laboratories. Analysis of cremains in the Tri-State example with over 300 potentially questioned identities illustrates the possible magnitude of the task. Although some methods have been applied with success in single circumstances, such as the use of particle-induced X-ray emission, there are limitations, in such a case, there is the requirement for access to a megavolt particle accelerator.

Use of ICP implies an approach in which only elements in the trace levels are of interest, when in fact major elemental differences can be noted between the materials in question. From a major element perspective, cremains should contain only Ca and P in a ratio consistent with bioapatite (1). Concrete will contain significant amounts of Si, Al, and Fe in addition to Ca. Similarly, other readily obtainable materials such as drywall products or plaster of Paris contain significant amounts of S.

A first approach to analysis of such materials should employ techniques that are simple, rapid, and possibly less destructive. Such techniques include scanning electron microsopy/energy-dispersive X-ray spectroscopy (SEM/EDS), X-ray fluorescence (XRF), and X-ray diffraction (XRD). In SEM/EDS, the detection limit is around 1%, sample preparation is minimal, and elemental analysis can be obtained in minutes. The method also has the advantage of detection of foreign particles using contrast in back-scattered electron images. The use of this method in distinguishing dental and osseous tissue from other materials has been well reported and a database exists, curated by the FBI (1,2).

Laboratory-based XRF analysis is a nondestructive technique that can also quantify both major and trace element concentrations. XRD also is nondestructive and can identify the crystalline structure of major phases in a sample. All three techniques mentioned are readily accessible, relatively inexpensive, and could be used to answer the analytical question.

To demonstrate analysis by SEM/EDS, human cremains, concrete, gypsum products, and wood ash were analyzed both alone and in 50/50 by volume mixtures. The results immediately show the utility of major element analysis approach. Adulteration of the cremains always caused a change in the Ca/P ratio. In addition, all the mixtures could be distinguished from cremains by detection of significant concentrations of Al, Si, S, Ti, or Fe (Table 1). Statistical treatment of the data was not necessary to reach these conclusions.

TABLE 1—*EDS analysis of cremains and cremains mixed 50/50 by volume with materials, atomic percent.*

	C	1	2	3	4	5	6
Na	6.1						
Al		2.8		4.1		2.7	
Si		**5.3**	**10.7**	**28.5**	**9.9**	**6.6**	**3.0**
P	**28.7**	15.5	12.7	5.6	4.4	7.8	5.2
S					1.3	**24.1**	**34.7**
K	2.7	6.8	1.6	1.6		1.9	
Ca	62.5	69.7	72.1	56.9	76.1	55.6	57.2
Ti					**8.4**		
Fe			2.8	3.3		1.3	

The presence of Si, Al, Ti, and S distinguish all mixtures from the unadulterated cremains. Also if the Ca/P ratio changes significantly then cremains may be suspected. Bold indicates levels of elements that can be used as discriminators.

C, unadulterated cremains; 1, wood ash; 2, concrete; 3, quick setting concrete; 4, grout; 5, gypsum joint compound; 6, plaster of Paris; EDS, energy-dispersive X-ray spectroscopy.

There are few descriptions in the literature of analysis in this area. The authors of the study under comment are to be congratulated for a well written and scientifically executed study. A much simpler approach, however, would resolve the issue of whether cremains have been adulterated. The purpose of this commentary is to bring awareness of other established techniques and approaches to the analytical question at hand.

References

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