justice

The object of forensic
science is to try to make sure that
the guilty are found out,
and that the innocent are protected.
One technique which
can be used by
the investigator is neutron
activation analysis.

Activation analysis is a nuclear technique used for identifying and assaying the amounts of certain elements in samples which may be almost too small for the eye to see. It is in wide use in the laboratory, and is being used increasingly in industry, medicine and elsewhere as a routine technique. In appropriate cases, activation analysis is used for the purpose of obtaining proof in criminal cases in at least five laboratories — three in the United States, one in Canada and one in the United Kingdom.

The name given the technique cloaks a simple method of operation. In one form of the technique which is in fairly common use, a sample is bombarded with neutrons inside a nuclear reactor. Radioactivity is thus induced in certain elements, and by using instruments to study the way they behave in this "activated" form they can be identified and measured in extremely small quantities.

This is, of course, only one of many techniques used in forensic work. For fairly large samples other physical and chemical techniques can be used. But activation analysis is extremely versatile and can be used in the assaying of samples of widely differing kinds without destroying them — often an important factor. It has one big disadvantage: it is not the kind of technique which can be used in the back room of a police laboratory. The sample must be irradiated, for the particular form of activation analysis being discussed here, inside a reactor; and if a police department were to wish to use this technique they would have to send a sample away to a laboratory which had suitable facilities.

Why, then, use this technique at all, if it requires such facilities? The answer to this question lies largely in the great sensitivity of the method. It may not be faster or more economical than other methods of analysis, but it makes possible analyses which could not be performed in other ways, and may give greater certainty.

Some aspects of the use of activation analysis in forensic science were described by Professor V. P. Guinn, of the University of California, Irvine, in the United States, during a visit to IAEA headquarters in Vienna. Prof. Guinn is a leading authority on the subject of activation analysis, and has had for some years a special interest in forensic work.

It was possible to detect a few elements in samples, he said, in quantities as small as one ten-millionth part of a microgram; a few could be detected only in amounts greater than about ten micrograms. The mid-range of sensitivity fell at about a thousandth of a microgram.

It was this great sensitivity which made activation analysis especially suitable for analysis of the sort of samples which might be found in forensic work. No criminal is likely to leave at the scene of his crime anything which he knows might be used to identify him; even if he attempts to remove clues to his identity he is likely to leave a hair or two, a scrap of fingernail, a trace of tobacco. When he is caught, ordinary techniques of criminal investigation may be enough to link the colour and formation of his hair with a hair he is thought to have left behind, his blood type may match a smear found at the scene, and so on. Neutron activation analysis may harden suspicion of his guilt to virtual certainty. No two individuals are alike in their actual body composition — particularly in the quantities of trace elements their bodies contain. A sample found at the scene of the crime, which may be very small, may be matched for its content of each of several elements with that of another sample, taken from the suspected source. The result of the analysis may convict — or aquit.

Each sample can be analysed for more than one element. Prof. Guinn put it in this way: "The principle used in comparing specimens is through their composition. Let us say you are examining samples of hair in a criminal case. If those two samples came from one particular person they should be quite closely similar, quantitatively, in all the elements you can detect in them. It is more or less like comparing fingerprints, trying to get as many independent points of comparison as you can. We have a lot of background data, and have some basis of comparison. In hair from different people you will find many of the same elements, it is true, but the concentrations will vary quite widely.

"It may well be that quite a number of people in this lecture room would have the same amount of chromium in the hair, but most people would be outside the range of a particular sample in one direction or another. It is the same for cobalt, the same for scandium. If you get enough elements to compare, it becomes possible to find out whether hair found at the scene of a crime came from *one*, particular suspect."

Prof. Guinn pointed out that this sounded as though it might take some time, but it is in fact quite a quick procedure. Each sample is handled in the same way, and a computer can be used to process many of the results. The difficulty when analysis had been completed was to assess the validity of the conclusion reached: how certain did a forensic scientist have to be? Cases where activation analysis might be used tended to involve serious offences such as murder, for which a suspected person's life or liberty was at stake.

"So, you look at the background data and calculate probabilities", said Prof. Guinn. "What *is* the probability that, really, these two samples came from different people and just happen to be alike? That is relatively easily done. You can calculate a probability of accidental coincidence. In one recent case in Michigan, by working through the numbers, it came out that 'yes, there was a possibility that the samples being compared really did not have the same origin.' But that probability was rather small — it was about one in a million... That is the approach one takes. You do not say, finally, with absolute certainty, without any doubt whatsoever, that this sample came from that person. All one can do legitimately, and this is true of all forensic work, is to draw a statistical conclusion and try to establish whether the probability is very high or very low that the two samples you are examining came from the same source. In the same way, you can say that they did not."

Prof. Guinn took hair as his first and prime example, but he pointed out that the same technique could be used in the analysis of marijuana, opium, paint marks or scrapings and so on, tracing each sample back to its suspected source; or, again, showing that the source was not the one suspected. The technique could be used, as well, in work such as that done in the prosecution of the illegal production of alcoholic liquor, which is known in parts of the United States as "moonshining".

"The US Treasury Department, more than my own group, has had quite a lot of experience in looking at moonshine whisky, non-taxed whisky," he said. "When some of this stuff is picked up the Department wants to prosecute somebody for making it. So the question arises, can you prove that this whisky was produced at a particular illicit distillery, in the hills?

"When you look at the sample using activation analysis, you can find almost the whole periodic table of elements. The producer's quality control leaves something to be desired. When you look at the still itself you can see why. To distill moonshine whisky they use whatever materials they have to hand — a car radiator, copper pipes for plumbing, lead pipes, galvanised metal, anything they can put together to make a still.

"In one analysis we. found as many as 30 elements in the sample. Correspondingly, in good whisky you may find traces of as many as five elements only. The Treasury Department, once when they were looking just for lead traces, were amazed. They found 30 parts of lead per million in the whisky. You could not really drink too much of that. You could kill yourself."

OBITUARY: HUBERT LEFÈBVRE DE LABOULAYE

Hubert Lefèbvre de Laboulaye, who died on 21 January in an aircraft accident while on an official mission, was one of the Agency's first Deputy Directors General, holding office from 1958 to 1961.

Born in 1921, he studied at the Ecole Centrale in Paris and then at the Duc de Broglie's Laboratory, where he took up physics. In January 1947 he was among the first physicists to join the Commissariat à l'Energie Atomique, where he collaborated in the neutron experiments performed with the first reactor before moving on to nuclear physics. Starting in 1955 he participated in the international negotiations in the nuclear field which led to the organization of the first United Nations International Conference on the Peaceful Uses of Atomic Energy, held at Geneva, in the establishment of EURATOM and in the creation of the Agency. On returning to France from Vienna he became head of the Programme Department of the Commissariat à l'Energie Atomique.

As Deputy Director General of the Agency he did much to promote economic studies and the drafting of international regulations for radiological protection.