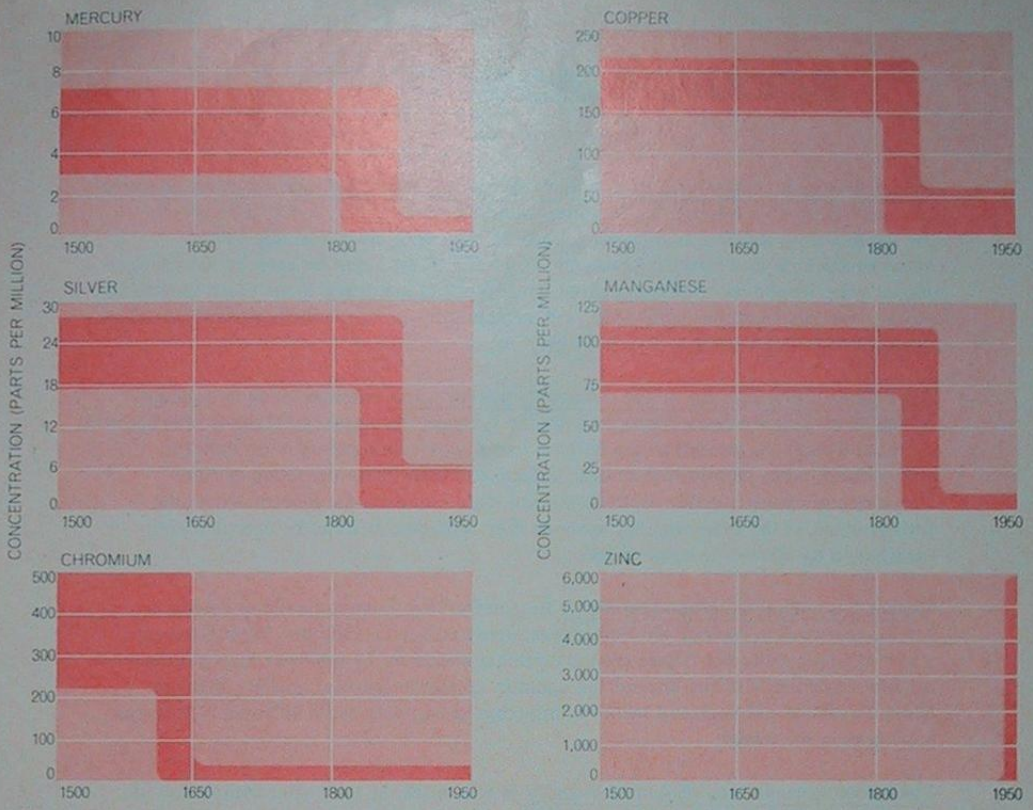

PAINTINGS CAN BE DATED by measuring the concentrations of various trace elements in white lead paint, which has been used as a primer and white pigment since the Middle Ages. The changes in trace-element content are related to changes in the metallurgical techniques used to purify lead. The neutron-activation technique requires less than a milligram of white lead to perform a complete analysis. Graphs are based on data obtained by Jan Houtman and J. Turkstra of the Reactor Instituut at Delft in the Netherlands.

accurate and broadly applicable methods for the measurement of minor and trace elements in biological specimens. It is being used to elucidate the role of trace elements in normal and abnormal physiological functions. Typical subjects of study include selenium in "white muscle" disease, manganese in heart disease, arsenic and molybdenum in uremia, copper and manganese in leukemia and zinc in the formation of kidney stones. Cadmium, mercury and uranium (in addition to arsenic) are analyzed in biological samples to evaluate evidence of poisoning. Chronic poisoning is distinguished from acute poisoning by analyzing blood, urine, stomach fluids, fingernail clippings and hair. Abnormal concentrations of poisons in all these substances indicate chronic, or long-term, exposure; abnormal concentrations in all but the fingernails and hair indicate acute exposure, since it takes time for the hair and fingernails to grow.

Although the neutron-activation technique is used almost exclusively to detect various chemical elements and measure their quantity, it is basically an isotopic method; it is the particular isotopic nucleus that interacts with the neutron to produce a given radioisotope of an element. The technique is applicable to elements only when the isotopic abundances of a sample are known. This is the case in most samples, because the elements are present in their natural isotopic abundance. The technique is now being used with increasing frequency, however, as an isotopic method of analysis, especially in studies of human metabolism. Radioisotopes are routinely used in diagnostic studies of the changes in normal body functions caused by disease. Nonradioactive isotopes can also be used, and indeed they have certain advantages. An enriched nonradioactive isotope of iron has already been used for studies of the function of iron in blood plasma and a stable isotope of calcium has been used to determine the metabolic pathway of calcium in children. In general the method involves the administration of a nonradioactive salt enriched in a specific isotope. Measurement of the change in the concentration of the administered isotope over a period of time provides useful information about its metabolic role. The major advantage of using a nonradioactive isotope as a tracer is that the patient is not subjected to radiation, a consideration that is particularly important in studies of children and pregnant women.

We have described here only a few of the many applications of the neutron-activation technique. Because it can be used to analyze samples of virtually any size for their content of at least 70 elements, and to do so to within, on the average, a billionth of a gram, this product of basic nuclear research will be an increasingly useful tool.