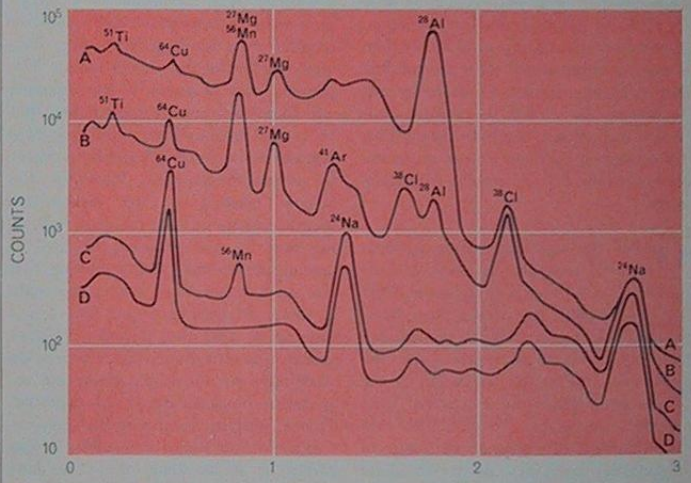
paring the paint with the paint of authenticated works.

Most of the trace-element analyses performed by the neutron-activation technique are of course more mundane than the ones just described. Nonetheless, the technique has played a key role in solving many important technological problems. For example, it has been used in the development of purer materials for manufacturing transistors, high-strength metal alloys and plastics. One noteworthy problem that was solved had to do with certain epoxy resins, which originally had a short and unpredictable shelf life. A neutron-activation analysis of these resins revealed the presence of very small amounts of a number of metals. When these trace contaminants were removed, the shelf life of the resins was extended considerably. Apparently the trace contaminants had catalyzed the fixing of the resin.

Neutron-activation techniques are also used to characterize raw materials by their trace-element content. In one of our studies at Union Carbide we discovered that the trace-element content of the mineral chromite in ore deposits is constant within a given deposit but is quite different from that found in other deposits. This information is useful for measuring the extent of a given deposit and for determining why one source of ore gives rise to a better product than another. Petroleum geologists, using a similar approach, employ trace-metal analysis to determine the extent of oil reserves, the stratigraphic position of oil traps, the age of crude oils and the fundamental principles governing the origin, migration and alteration of petroleum. Soils from widely separated locations also show large variations in trace-element concentrations; as a result vegetation exhibits trace-element characteristics peculiar to the area in which it grows. Such information is used by geologists to locate new ore deposits, by ecologists to study the relation between the growth of certain trees and shrubs and their environment, and by official investigators to identify the original source of raw opium that has been confiscated.

The neutron-activation technique has developed into one of the most sensitive,



RADIONUCLIDE	HALF-LIFE	RADIONUCLIDE	HALF-LIFE
ALUMINUM 28 (^{28}Al)	2.3 MINUTES	ARGON 41 (^{41}Ar)	1.83 HOURS
TITANIUM 51 (^{51}Ti)	5.8 MINUTES	MANGANESE 56 (^{56}Mn)	2.58 HOURS
MAGNESIUM 27 (^{27}Mg)	9.5 MINUTES	COPPER 64 (^{64}Cu)	12.9 HOURS
CHLORINE 38 (^{38}Cl)	37.3 MINUTES	SODIUM 24 (^{24}Na)	15 HOURS

SIMULTANEOUS ANALYSIS of a number of elements in a sample is possible using their gamma ray spectra. The spectra shown here were recorded for a neutron-irradiated piece of paper after decay periods of three minutes (*A*), 10 minutes (*B*), four hours (*C*) and 24 hours (*D*). The peaks in the spectra can be identified by referring to the key at bottom. Because of the different half-lives of the elements, the analysis of a particular element can be facilitated by choosing a decay time when the emissions from the "indicator" radionuclide are least interfered with by the emissions from other radionuclides in the sample.