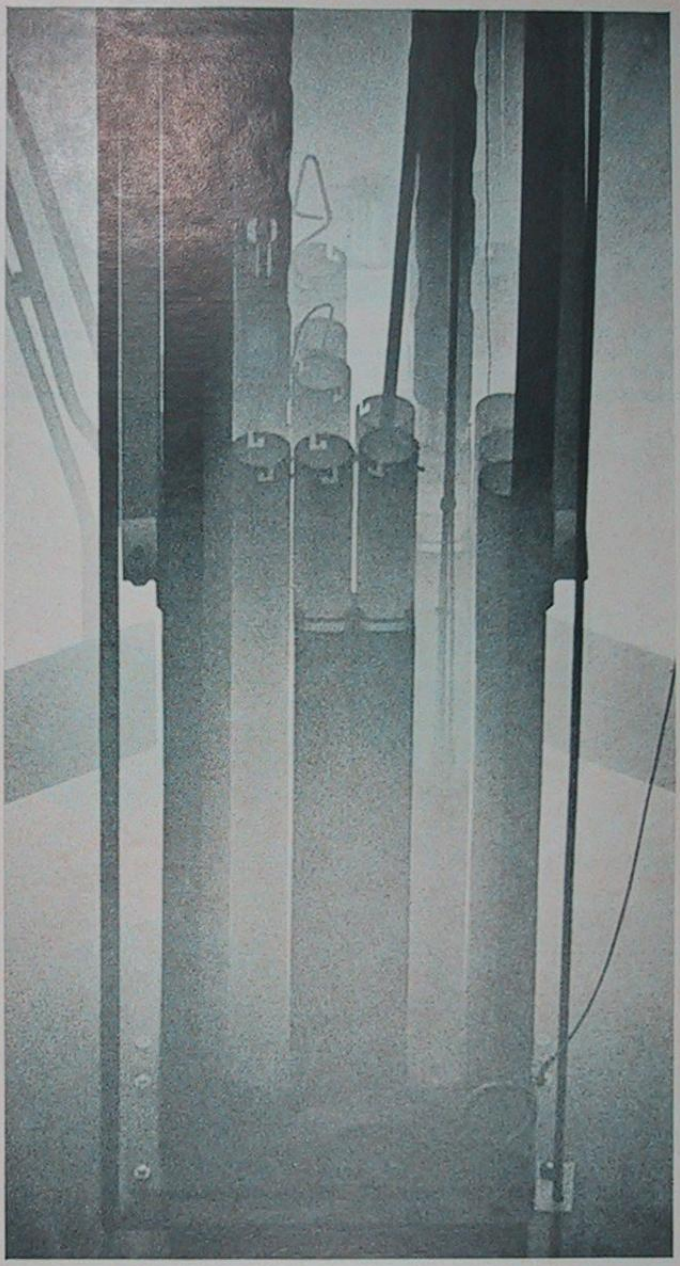
concentration of a particular stable isotope in the original sample.

For each radionuclide the amount of radioactivity induced is proportional to the number of nuclei of the original stable isotope, the number of neutrons that are available to interact with the nuclei (the neutron flux) and the probability that a neutron will interact with a target nucleus. Every neutron that enters the sample does not interact with a nucleus, of course; the spacing between the nuclei is so large compared with both the size of the nuclei and the size of the neutrons that most of the neutrons will pass right through the sample. Only when a neutron comes fairly close to a nucleus does it have a chance to be absorbed. In somewhat oversimplified terms, the probability of an interaction between an incoming particle and a target nucleus is proportional to the apparent cross-sectional area presented by the target. According to this analogy the probability of a neutron-nucleus interaction is called the cross section of the interaction and has the dimensions of an area.

The number of radioactive nuclei in an irradiated sample also depends on how long the sample was exposed to the neutrons and on the characteristic decay rate of the radioactive nuclei, which begin to decay as soon as they are produced. The net rate of production of a radionuclide is equal to its gross production rate minus its decay rate. The radionuclide to be measured is usually not present in the original sample; consequently during irradiation the gross production rate initially far exceeds the decay rate. These two rates approach each other at an exponential rate that depends on the half-life of the radionuclide. (The half-life is the characteristic time required for half of the nuclei in a population of radioactive atoms to decay.) In time the net rate of production will be zero, and no more radioactivity will be produced. This phenomenon is called saturation.

In practice the sample is exposed to neutrons long enough to produce a measurable activity of the particular "indicator" radionuclide formed by the element that is being assayed; then the sample is removed from the irradiation zone and its induced radioactivity is measured. Activation ceases when the sample is removed, and in time all the induced radioactivity will decay. Thus the amount of each radionuclide present at any time after neutron bombardment is influenced by those factors that are fixed for a given sample (the number of



NUCLEAR REACTOR is used by the authors and their colleagues as a source of neutrons for activating samples of various materials. The neutrons are emitted as a by-product of the fission of uranium 235, which takes place in the vertical pipelike fuel elements visible in the center of the photograph. The entire reactor is immersed in a large tank of water in order to slow down the energetic neutrons emitted by the fission reaction. The sample to be activated is transferred into the reactor in the vicinity of the fuel elements. The glow surrounding the fuel elements is called Cerenkov radiation; it is produced by the passage of fast electrons through the water. The photograph was made solely by the light of the Cerenkov radiation.