Neutron Well Logging

A New Geological Method Based on Nuclear Physics

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Preliminary discussion of a new well-logging process adapted for use in cased or uncased wells. The process involves a neutron source and an ionization chamber. Remarkable detail is evidenced in the logs, which show very good correlating power and give considerable new information, in the examples studied. The equipment is very much the same as for radioactivity well logging.

SINCE April 1940, when radioactivity well logging was offered to the trade by Well Surveys, Inc., the laboratories of the company have been engaged in continuing the search for new curves. The development of an additional parameter has fortunately become possible at a time when the commercial experiences in the United States and in South America have shed considerable light on the usefulness of radioactivity well logging. A second curve should necessarily operate independently of casing and possess the detailed correlating power of the radioactivity log, and, above all, should add some new information. At the time of this writing, the initial field trials have been completed on a new process, neutron well logging, which appears to fulfill the foregoing requirements.

The well-logging instrument consists of a strong neutron source (radium plus beryllium) and an ionization chamber, so arranged that the ionization chamber is considerably shielded from the rays coming directly from the source (Fig. 1). As a consequence of the interaction of the primary rays from the source with the surrounding formations, the indication furnished by the ionization chamber varies with the properties of the strata. What radiations do come through the shield directly from the source are a constant amount throughout the log. The present experimental subsurface instrument is a single cylindrical unit, similar to the one used for radioactivity logging. The maximum outside diameter of the present experimental instrument is 5½ in. The total length of the subsurface instrument including the amplifier and the power supply is 7 ft.

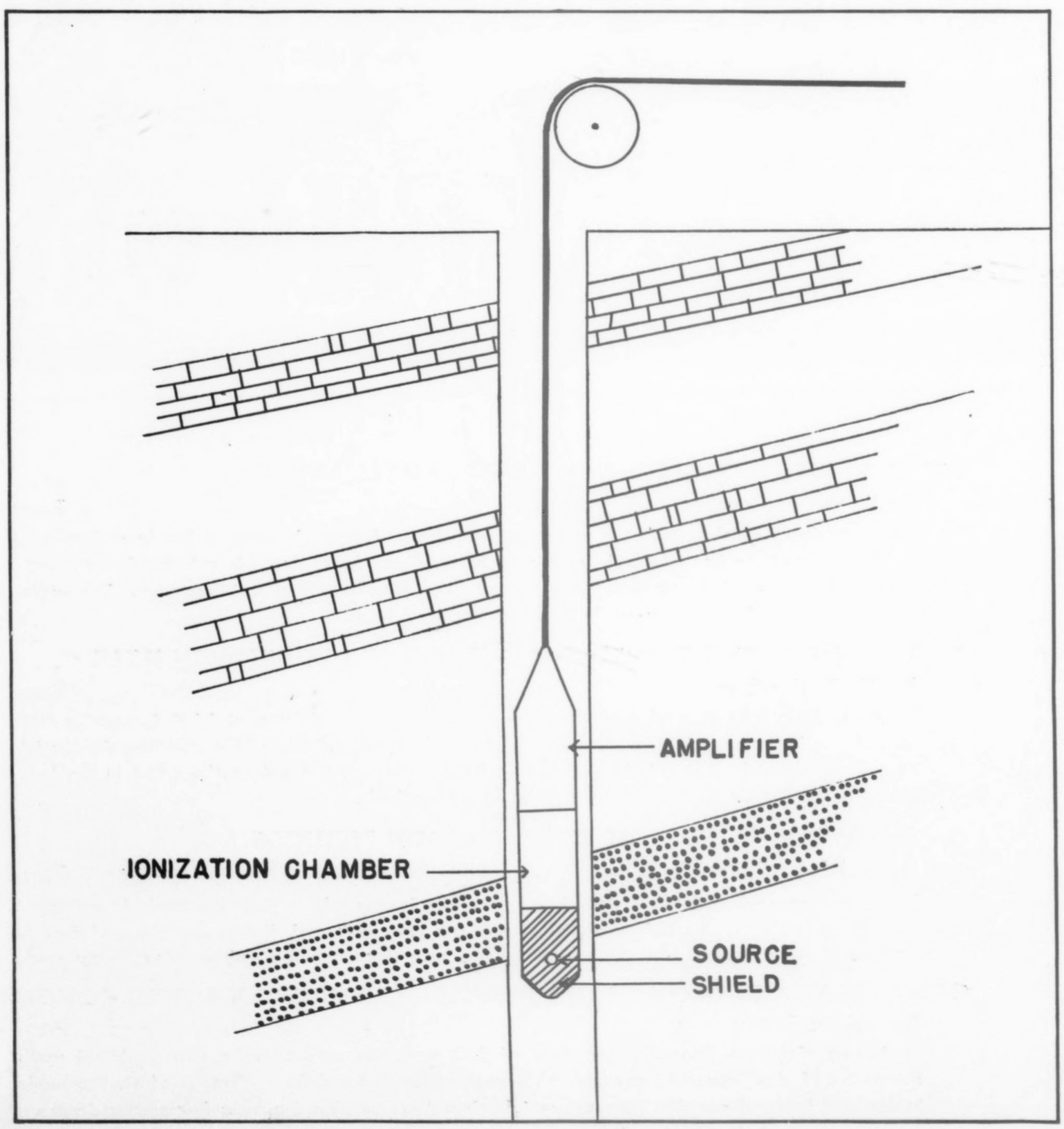

Fig. 1—Diagram showing the arrangement of the various components of the subsurface equipment with respect to the neutron source

The curves shown in Fig. 2 give good correlations, as can be seen. It is likely that the new curve will add enough new information to make possible the distinction of many types of strata which, hitherto, could not be recognized. Particularly, it is hoped that the new curve will:

1. Distinguish limestones from sandstones.
2. Distinguish more easily from shale the various rock types which consist of other materials mingled with shale.
3. Enable new and useful correlation horizons to be found in shales.
4. Enable some information to be gathered, by comparison, which will help in regard to the fluid content problem.

It seems at present that the neutron logs may be very valuable in areas where the producing formations are limestones and dolomites. In general, the neutron curves give geologists a new tool to work with, which may be applied equally well to old or new wells. It is certain that the neutron well-logging method is able to log in cased and uncased holes alike with comparable results, and that the logs are characterized by deep penetration. It is also certain that valuable logs can be made in areas of salt beds, such as West Texas and western Kansas, and in places where the various electrical-logging methods fail.

Because the strength of the neutron source can be made quite large, the surveying speed which may be realized with the new method is very great, fully comparable with the speeds used for electrical logging. As a result of the large intensity involved, it is possible to make the measurements in a manner which is very little influenced by drifts and temperature disturbances.

The neutron curve is entirely different from the radioactivity curve. The gamma rays emitted by the radioactive elements present in small quantities in the formation, which are measured in the radioactivity well-logging process, have a completely negligible effect in the neutron method.

The field studies of the new curve are progressing rapidly, as are laboratory studies designed to improve the interpretation. Since the process is adapted to the use of the standard field equipment now being employed in commercial radioactivity well logging by licensees of Well Surveys, Inc., the field tests can be conducted very easily, and automatic records are obtained in the same manner as for the radioactivity logs. If favorable results continue, the new process will be offered to the trade shortly.

Acknowledgment

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Fig. 2—Section about ½ mile long in the Oklahoma City pool, showing the correlation of neutron logs obtained through the casing and cement, and the comparison of the neutron logs with the resistivity curve of an adjoining well, made in open hole. Note the striking resemblance of the neutron curve to the resistivity curve, the great distinctness with which the geologic formations stand out, and the remarkable manner in which the details of the lithology correlate between one neutron log and another. The depths shown are for the resistivity curve at the right. The neutron logs are adjusted so that the top of the Oswego limestone in all three neutron logs is level with the top of the Oswego in the resistivity log