8. Comments

A large proportion of the equipment described above has appeared on the Australian market in the last two years, and it can be expected that many more products will appear in the near future.

THE DEVELOPMENT OF GEOPHYSICAL LOGGING EQUIPMENT AND SERVICES FOR MINERAL AND HYDROGEOLOGICAL INVESTIGATIONS IN SOUTH AUSTRALIA

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Electric wire line logging has been a commonly used geophysical tool in the oil industry for many years. However, exploration for minerals and underground water has not been as well served and logging probes have generally been adapted from those used in the petroleum industry.

The development of equipment to solve specific problems in these areas of exploration and the establishment of accepted standards for logging have been tardy for several reasons.

(a) There is no overall regulatory body, similar to the American Institute, which can impose standards for mineral and underground water logging practices.

(b) In general, mining companies have limited resources for research and development, compared with the oil companies.

(c) Underground water investigations are frequently undertaken by public utilities with a limited exploration budget and only the simplest forms of geophysical logging are applied.

(d) Many mining companies perform their own logging and thus set their own standards.

(e) Equipment manufacturers supply many clients who each set their own standards.

The development of new equipment and adherence to standards is thus left to those companies whose resources, both financial and in personnel, permit expenditure on research, or to government authorities who can perform these functions as a service to industry. On this basis, the South Australian Department of Mines and Energy is engaged on development of some new techniques and standards for application in South Australia.

Figure 1 illustrates the concept which the Department has adopted, and whilst there is nothing new in combination tools, electronic depth measuring systems, truck borne computers or real time printout, the aim is to develop a set of equipment and logs, calibrated against established and accepted standards, which can be quantitatively rather than qualitatively interpreted.

The family of radiometric tools, viz. gamma ray, neutron and density, are the most difficult to make calibration standards for. The density and neutron tools can be provided with calibration blocks to be used as secondary standards, but no such acceptable standard was available for gamma ray equipment, which is the most frequently applied tool in radiometric logging. The need for a set of primary standards was therefore considered of major importance.

The Australian Mineral Development Laboratories were commissioned by the South Australian Department of Mines and Energy in 1977 to design and construct a series of calibration standards for gamma ray logging tools. By March, 1979 three pits had been completed with nominal ore zone concentrations of 0.04, 0.18 and 0.80% U_3O_8. Each pit contains three zones, with a simulated ore zone between an upper and lower barren zone. The ore zones each approximate an infinite thickness for gamma rays at their axes. A central bore hole was made by diamond drilling ghrough the three zones, leaving sufficient thickness of concrete at the bottom to ensure that no water loss from the bore hole would occur.

The pits were constructed by setting 'Humespun' concrete manhole shafting with an inside diameter of 1.219 m in a hole of diameter 1.5 m and depth 6.5 m. The concrete was poured in three stages over three days, with the ore zone being 1.4 m thick. The ore was gradually fed into the back of the concrete mixer as the other ingredients were being added and blended and mixing of the entire load was performed for over one hour. Samples were taken during pouring to test the homogeneity of the ore zone mixture.

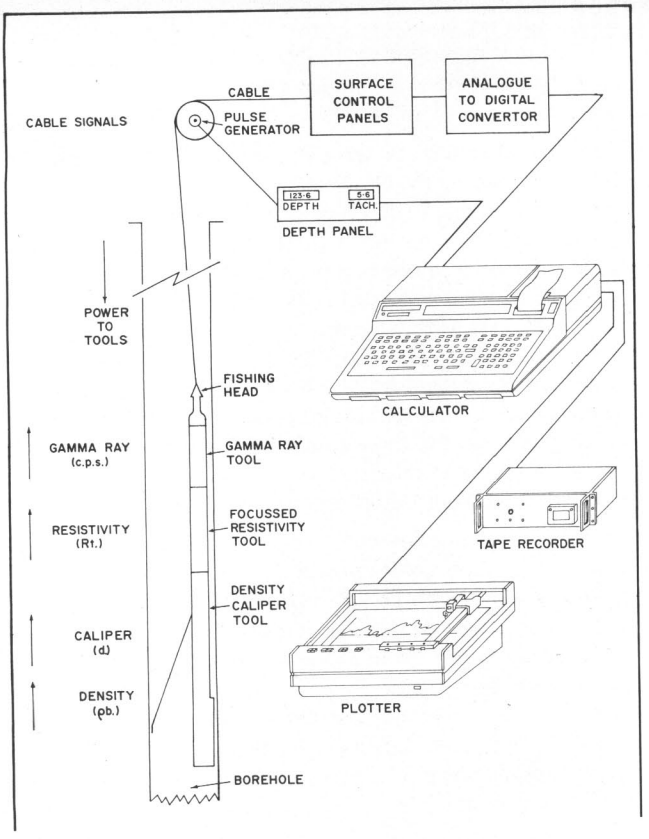
After two weeks, a hole with a diameter of 108 mm was diamond drilled to within 200 mm of the bottom of the pit. Assays and testing of the cores enabled checks to be made of the homogeneity of the ore zone, the concentration of the ore, and porosity of the pit material. The hole was drilled 1° off vertical so that probes would contact the same side of the hole on each run.

The pits may be logged either air or water filled, as water filling and pumping facilities are available on the site. Preliminary runs made by the South Australian Department of Mines and Energy show good profiles with a flat plateau over the ore zones. The three pits allow linearity and dead time checks to be made on logging tools and surface panels.

The basic pits were completed in March and ancillary facilities in May, 1979. The pits will be logged at regular intervals for a period of six months to determine their stability. When they have been accepted as stable primary standards, discussions will be held with contractors, exploration companies, academic staff and government authorities to decide on a standard method of use, calculation of K factor, optimum frequency of equipment calibration, establishment of secondary standards, etc.

Development of logging equipment has included an electronically calibrated depth measuring system to provide depth data for a digital acquisition system. Additions to the 'depth' panel are envisaged which will allow a digital readout of cable tension, automatic speed control of the winch, and sufficient 'intelligence' to provide some automation for the winch control system, e.g. to cut out when the tool reaches bottom or stands up on the way down the hole. Work on this system has provided a useful exercise in the production of a major piece of electronic equipment.

To assist in underground water investigations, a focussed resistivity tool is being developed to measure formation



COMPUTERISED PROCESSING AND PRESENTATION OF BOREHOLE DATA

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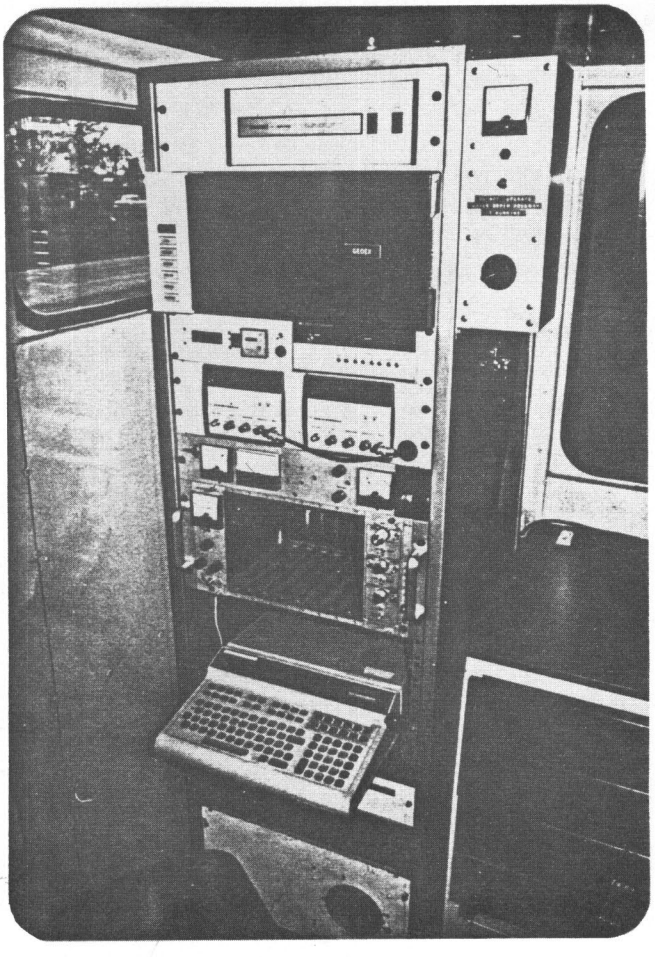
The installation of a computer in logging truck for the recording analysis and presentation of borehole data offers many advantages over analog recording. Digital acquisition on to standard computer tape improves data banking and storage, facilitates interpretation with other borehple information and provides a ready format for any further processing requirement.

By providing sufficient programming capacity in the field unit, various types of processing and interpretation can be performed on-site. Spurious readings such as sonic velocity cycle skipping can be rejected by software criteria and borehole-effect corrections applied immediately. The derivation of physical properties such as density, porosity, etc. and the interpretation of ore-grades; coal ash content and yield; rock strength index; bed boundary and thickness; and lithology can be made and stored on tape.

GEOEX
Computerised Borehole Logging



Control Room – Instrument Rack

resistivity beyond the invaded zone. The tool will mainly be used to determine the quality of water in situ and so avoid the expense of obtaining and testing water samples. With the introduction of cable designation standardization, combination tools and digital surface equipment, a real time plot of formation water resistivity is feasible.

In producing water wells, a major problem is the breakdown through corrosion of steel casing in contact with saline aquifers, which results in an intermixture of saline with potable water. To investigate the condition of the casing so that remedial action can be taken, an ultrasonic casing corrosion detector is being developed in conjunction with the Australian Mineral Development Laboratories. The use of ultrasonic radiation for gauging metal thickness is an established laboratory technique and the difficulties which must be overcome in adapting this to borehole conditions include packaging, temperature limitations, movement of the sensor to scan the whole of the casing wall and transmission of data and power for the tool on a four wire cable

While the Geophysics Division of the Geological Survey of South Australia is only capable of undertaking a limited amount of research and development, the rationalization of its logging techniques and the extension of the range of available logging tools is being pursued as a service to exploration in this State.