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Geophysical logging in subsurface studies: non standard applications and new trends.

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Geophysical borehole logging techniques were originally designed and developed for hydrocarbon exploration in the subsurface. Following the first electrical logging tools designed for basic permeability and porosity analysis other logging methods were developed to obtain accurate porosity and permeability calculations and estimations (sonic, density and neutron logs) and also basic geological characterization (natural radioactivity). More recently "geological" logging tools were developed to provide the oil industry with specific geological information like oriented borehole measurements and images. Borehole imaging techniques are based nowadays on different physical properties (resistivity, acoustic, optical, density or natural gamma ray) and make possible the direct observation and measurement of the size and orientation of geological features (bedding, fractures, faults, textures, bioturbation, etc). Other techniques have been recently developed for precise fluid and porosity analysis like nuclear magnetic resonance.

The effectiveness of geophysical logging techniques in the study of the subsurface is also known in hydrological and mining investigation. Logging techniques have been extensively applied in the last decades in water and mining prospection. The availability of slimhole logging tools adequate for logging in relatively small diameter holes like those commonly drilled in mining and hydrogeological exploration has favoured the use of geophysical logging tools for these purposes. As a consequence this has favoured the development of slimhole tools with improved performance and capabilities and also of new tools based on other geophysical techniques, following the techno-

logical developments of new logging techniques achieved in the oil industry. Among other, logging through PVC casing as a new development for full waveform tools and ultrasonic imaging tools. New challenges for the development of slimhole tool equipments are the design of modular equipments to combine the different logging tools on a single string in order to improve time efficiency and also the development of logging while drilling capabilities to log in unstable environments.

The availability, portability and relative low cost of slimhole logging equipments has favoured the use in non conventional studies and are more and more used in a variety of environmental and geothechnical studies, subsurface storage studies and even in non-commercial fields like scientific subsurface volcanic and seismic hazard research.

A number of examples is presented covering conventional reservoir sedimentological and structural studies of oil exploration logging data and also non-conventional applications in geological and geotechnical studies for tunnel construction and subsurface studies applied to evaluations for underground geological storage and subsurface studies related to geohazard evaluation.