Exploration Methods for Late Quaternary Shallow Biogenic Gas Reservoirs in the Hangzhou Bay Area, Eastern China

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More than 20% of the world's discovered gas reserves are considered to be of biogenic origin. The significant late Quaternary shallow biogenic gas accumulations of the eastern coast of China are found in the Hangzhou Bay area at depths from several decameters to more than a hundred meters. Since 1991, six shallow gas fields and one gas pool have been discovered in the Hangzhou Bay region. Their discovery shows that this kind of shallow biogenic gas can be explored and exploited.Based on long-term research and practice, a series of methods and techniques have proven to be applicable in the exploration of shallow biogenic gas, including cone penetration tests, shallow shear wave seismic, soil-gas radon analysis, microbiological prospecting and electromagnetic surveying.

Because of the relationships between the cone penetration curves and lithology, cone penetration tests can be used to establish stratigraphic divisions and correlations and for reservoir identification. The top surface of a gas-bearing sand bed shows a strong reflecting boundary on shear wave seismic profiles, and this reflection boundary sharply declines when a gas-bearing sand bed pinches-out. Thus, the delineation of a gas-bearing sand body can be visualized on a seismic profile. The content of radon is higher over the boundary of gas pools than over gas pools and outside of field limits. A high concentration of radon can indicate the boundary of a gas pool. The concentration of methane-consuming bacteria, flavobacterium, bacillus, acinetobacter, xanthomonas, and pseudomonas in the soil can reflect the presence of biogenic gas in the subsurface.

Resistivity curves can be useful to judge whether the gas is present and to estimate the thickness of a gas layer. Abnormally high resistivity values often are the expression of a gas-bearing zone. Shallow gas exploration can be improved by combining the above methods. Cone penetration tests and large spacing microbiological surveys can be used to confirm the favorable exploration area. To define the detailed distribution of gas-bearing sand bodies, shallow shear wave seismic, small spacing microbiological, and radon anomaly analysis should be applied. Electromagnetic exploration methods can be used to establish the exploration depth. To enlarge the known gas field, densely spaced drilling CPT and the electromagnetic exploration can be carried out.