

**Cross-well Electromagnetics:
Technologies for reservoir monitoring,
image and characterization**

Dr. Ping Zhang

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**In-person in Room 325 at McCone Hall
(UC Berkeley campus) and on Zoom**

Abstract:

Cross-well EM, initially developed in the 1990's, involves applying inductive physics and 2D/3D inversion to interrogate the interwell resistivity distribution. The method has developed into a mature technology in the oil and gas community, especially for EOR and time lapse studies.

A cross-well EM system consists of a transmitter in one well that broadcasts a time varying magnetic field in the 3D region surrounding the boreholes, and multiple receivers that detect the magnetic field in another well some distance away. The collected data are used to image the interwell conductivity structures. Due to the diffusive nature of the EM fields coupled with the low data density provided by the cross-well acquisition geometry, the 2D/3D inversion problem, which non-linearly maps the measured data to an image of resistivity, is inherently ill-posed and non-unique. Extra efforts has to be exercised to extract reliable resistivity images from the measured cross-well EM data.

This presentation will outline the theory of cross-well EM system, data acquisition configuration and workflow. Two field examples will be presented to demonstrate the usefulness of the method for fluid monitoring and reservoir characterization. The first example is time lapse survey in Middle East to monitor water flood. The project consists of five surveys in two and half years. The data and interpretations clearly demonstrate the water flood pattern and effectiveness of using cross-well EM for monitoring. The second example is from a cross-well EM survey on two horizontal wells, the first ever in the world. The purpose of the survey is to map water flood path through a system of fractures. The data interpretation requires 3D modelling/inversion, a very challenge task considering the limited data coverage. The final resistivity model clearly revealed structures possibly related with fracture corridors and bypassed oil.

Presenter's Bio:



Ping Zhang received his PhD degree in geophysics from Uppsala University in 1989. He was an assistant researcher in University of Montreal, Canada from 1990 to 1994 and an area geophysicist for Inco Ltd, a mining company in Canada from 1995 to 1998. He joined Schlumberger in 1999. He is a Principal Geophysicist before retired at 2021. His research has focused on the applications of electromagnetic (EM) technology for geophysical exploration and formation characterization, with emphasis on developing numerical techniques that are used for interpretation of EM data. He was a principal developer for cross-well EM technology and worked on data processing, inversion and interpretation for petroleum applications. Recently, he was actively involved in studies and development of using down hole resistivity logs for CEC determination and clay typing. In addition, he is also actively engaged in a research effort of using low frequency permittivity for estimating saturation in a freshwater reservoir. He has published and co-authored more than 50 peer-reviewed and conference papers. He holds 12 granted patents.

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