Using Interwell Resistivity for Mapping Steam Chest Development at the Kern River Oil Field

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In 2002, Schlumberger and ChevronTexaco conducted field tests with a new cross-well electromagnetic system (EM) at the Kern River oil field in southern California. The tests were designed to measure the interwell resistivity distribution between steel-cased observation wells spaced from 500 to 1000 ft apart at depths from 400 to 1200 ft in the steamflooded reservoir. The object of the tests was to explore the role of faults in distributing steam within the reservoirs at Kern River.

The EM provides both an interwell resistivity distribution and an estimate of the resistivity changes that have occurred since the observation wells were installed. Field tests were made at the Reed Crude lease in the central portion of the field and at the Toltec lease in the north. At both sites the EM measurements revealed significant volumes where resistivity has recently decreased, as well as places where resistivity increases are observed. The resistivity has typically decreased in layers where the subsurface temperatures are still rising due to the recent introduction of steam. Places where the resistivity has increased are often associated with more stable temperatures and more established steam floods. The resistivity increases likely reflect changing saturation conditions due to production.

At the Reed Crude lease we observed that small faults, mapped using detailed reservoir modeling, might be associated with re-directing the injected steam into shallower layers. The faults correlate spatially with regions where the resistivity has recently decreased, which suggest that they can be used as local conduits for steam. At the Toltec lease, where there was little evidence of faults, large resistivity decreases were spatially associated with the heating of a recently found "cold spot." The steam flood bypassed this region until a recently drilled observation well identified the reservoir temperature anomaly. A broad region on the interwell resistivity section where the resistivity has decreased by 20-50% reflects recent steam injection.