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FLUID WITHDRAWAL AND PRECISE MEASUREMENTS OF HORIZONTAL CRUSTAL MOTION: A TEST

Hadley Johnson and Duncan Carr Agnew

Institute of Geophysics and Planetary Physics
University of California, San Diego
La Jolla, California 92093-0225
(858) 534-2590; (858) 534-5332 (fax); dagnew@ucsd.edu

ABSTRACT

To understand the earthquake hazard in urban areas using geodetic observations of tectonic deformation, these observations must be corrected for nontectonic effects, including ground deformation caused by the withdrawal and recharge of fluids (in many areas, water; and in the Los Angeles region, hydrocarbons as well). We investigated modeling such effects in the Los Angeles area, specifically in the Wilmington oil-field—one of the classic areas of such subsidence.

We obtained existing geodetic data (leveling and EDM measurements) that have been made over the past 30 years by the Long Beach Department of Oil Properties in order to monitor the effects of injection to replace the oil withdrawn. Our primary aim was to intercompare the horizontal and vertical data to see if, in a realistic setting, these would show comparable amounts of motion. A comparison of the two datasets indicates that, while the amounts of relative motion are indeed comparable, only in some cases do they match well. This is in accordance with what would be expected from simple elastic models of deformation, so that it would appear feasible to use these for correction of some at least of the geodetic measurements.

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NONTECHNICAL SUMMARY

The motion of the ground along plate boundaries reflects the buildup ot stress that causes earthquakes. However, in areas of oil or water pumping, the removal of these fluids from the ground will also produce motion, which confuses any interpretation of the measured ground motion in terms of earthquake hazard. In order to understand such fluid-induced motions better, we examined a dataset from the Wilmington oilfield, in the Los Angeles area, which measured both horizontal and vertical motion. We found that these two kinds of motion were of the same size, which implies that we cannot simply regard measured horizontal motions as evidence of earthquake stress buildup, if there is pumping nearby.