Gas Production, Storage and Hazard Controlled by Microgravity Surveys

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ABSTRACT

Natural gas represents one of the most important energy commodity. Gas production and re-injection are in primary focus of oil companies. Monitoring fluids in reservoirs, gas in particular, is considered an essential tool for controlling active gas fields. Beside expensive and logistically complicate 4D-Seismic, applied mainly offshore, other geophysical techniques can assist to gas monitoring, including IOR/EOR processes. 4D-Gravity has a proven potential for gas/water or gas/oil contact movement monitoring within a reservoir. Analytical modelling showed 4DG signal decrease with depth, but there still can be observable signal in case of favourable geometry, depth and thickness of reservoir. Porosity of gas saturated layer affects the final density contrast of the zone saturated by gas on one side, and water (oil) on the other side. The unique advantage of 4D-Gravity is that the technique can be applied even in urban or industrial environment, measurements do not require any cables along profile, and may be performed in very limited space. In ideal case, ‘easy’ surface 4DG survey would be accompanied by borehole gravity in a monitoring well located near the fluids contact in reservoir. 4DG has been successfully applied in various conditions in Alaska, France, Italy, the Netherlands, Norway, as well as in Ras Laffan, Qatar. This project may serve as a good example in the Middle East, as not only the sour gas from procesing trains was re-injected into reservoir formation, but the process aims at EOR as well. Potential hazard is represented by leakage of gas through gas ‘chimney‘ (fractured 2D or 3D zone). We performed a microgravimetric experiment in a shallow basin around signifiant CO2 degassing sites and succeeded to locate them as local gravity lows. In conclusion, 4D-Gravity can be applied, but feasibility modelling and simulation should be performed prior to project start-up. 4D model has to be based on particular local reservoir and fluids parameters. In one of the figures, as a general example, there are two EOR stages of fluids movement – gas injection (phase 1) and waterflooding (phase 2) with respective gravity anomalies.