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sedimentation and overpressure generation processes in the north western oil fields of Taiwan

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Anomaly high fluid pressure that is higher than hydrostatic pressure (overpressure) has been reported at several thick sedimentary basins and oil fields. This overpressure is generated by many factors, and one of the main mechanism for the overpressure generation is due to the continuous sediment accumulation that causes both an increase of fluid pressure and the growth of the consolidation with fluid drainage. Hydraulic properties for sedimentary rocks, such as permeability, porosity, specific storage, and Skempton's coefficient is necessary to analyze this non-equilibrial consolidation process quantitatively. It is expected that these parameters decrease with burial and consolidation. However it is not researched enough how these parameters change with consolidation, and specific storage and Skempton's coefficient at depths are not well known as well.

Therefore, in this study, the overpressure generation process was investigated at the north western Taiwan oil field where overpressure is observed at depths in wells. Samples are collected from surface outcrops to cover all stratigraphic horizons, and permeability and porosity changes with confining pressure changes are measured in laboratory experiments. For all experiments confining pressure was increased up to 200 MPa at room temperature. Permeability was measured by the steady state gas flow methods, and porosity change was evaluated using the isothermal ideal gas equation (Scheidegger, 1974). Specific storages and Skempton's coefficient are estimated from the result of changes in porosity with confining pressure. Fluid pressure distribution was estimated by one dimensional basin analysis (based on Bethke and Corbet,1988; Luo and Vessaur,1992; Wangen, 2001,etc.) incorporated with the experimental results, and compared observation data. The numerical analysis contains the possible overpressure mechanisms of the fluid volume expansion due to the geothermal gradient and the dehydration effect from smectite to illite.

Permeability, porosity, specific storage and Skempton's coefficient decrease with increasing depth of burial. Permeability shows rapid reduction from 10ˆ-13 mˆ2 at surface to 10ˆ-20 mˆ2 at 8 km depth. On the other hand, specific storage decreases less than 2 orders of magnitude with depth from 10ˆ-9 Paˆ-1 at surface to 10ˆ-11 Paˆ-1 at 8 km depth. Skempton's coefficient decreases from 1 at surface to 0.7 at 8 km depth. Permeability, porosity, and specific storage evolutions in relations with effective pressure are approximated by exponential decay curves. On the contrary, evolutional curve for Skempton's coefficient decreases linearly with effective pressure.

Our predicted overpressure was generated abruptly from 4 to 5 depth and increased with depths, and this trend is consistent with observation data. However numerical result was relatively smaller compared to observed fluid pressure. Additional influx of fluid from the depth, an error in estimated hydraulic parameters that might be different from real depths, and hydrocarbon generation would better explain the difference. Furthermore sediment overburden loading and dehydration effect strongly contribute to overpressure generations.

Same methods are applied to Taiwan Chi-Chi earthquake site, and the numerical result suggests that overpressure might be developed at depths. Furthermore on the condition that faults layers are developed at depths of the focal area, amount of overpressure becomes much more. This implies that overpressure was influenced on the Chi-Chi earthquake mechanism.