Spatio-temporal changes in sedimentation rate and its impact on overpressure evolution in offshore Suriname

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Overpressure has been recognized in many sedimentary basins around the world. Various geological processes have been proposed as mechanisms capable of generating overpressure conditions. However, many of them seem to be closely related to sedimentary processes in a basin. An increase of total stress by sediment loading leads overpressure formation by disequilibrium compaction (insufficient dewatering during sedimentation). Progress of sedimentation also results in heating of underlying strata, which induces geochemical reactions and overpressure generation by fluid expansion (an increase in the fluid mass in the pore space of a deposit). Previous research showed complex overpressure evolution in sedimentary basins in response to changes in sedimentation. However, overpressure evolution and the range of causal mechanisms has not been extensively compared with a full context of the spatio-temporal characteristics of the depositional history of an area.

The present study investigated the spatial and temporal changes in sedimentation rate and its relation to the overpressure evolution in the passive continental margin of offshore Suriname. This study conducted well data analysis to estimate the relevant overpressure-generating mechanisms. Three-dimensional basin modeling was subsequently performed to reconstruct overpressure evolution in the area. The results indicated that the temporal variation of sedimentation rate resulted in cycles of overpressure generation and dissipation in the region. Overpressure was generated during periods of high sedimentation, and it was released during the period of quiescent sedimentation. The spatial changes in sedimentation rate caused lateral changes in overpressure, with greater overpressure being produced in areas with higher sedimentation rate. Disequilibrium compaction generated larger overpressure in the area of higher sedimentation rate, due to faster increasing rate of sediment load. Fluid expansion produced additional overpressure in the deeper section beneath the high sedimentation area. Hydrocarbon generation played the secondary role in overpressure formation in such area, with minor contribution from dehydration during smectite-to-illte formation. As a result, significant overpressure develops beneath the depocenter by a combination of multiple overpressure-forming mechanisms.

The present study revealed that a single controlling factor (i.e., sedimentation rate) mainly caused the complex overpressure history and its lateral variations in offshore Suriname. This study gives an insight into overpressure evolution in other sedimentary basins, especially in the mud-dominated regions without the influence of major tectonic compression, by providing a viewpoint of the spatio-temporal variation of sedimentation rate and its impact on overpressure formation.

Keywords: Sedimentation rate, Pore pressure, Overpressure, Passive margin, Basin modeling

