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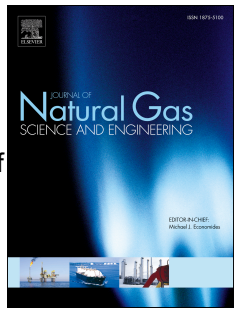

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Wellbore stability model for horizontal wells in shale formations with multiple planes of weakness

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Abstract: Wellbore collapse is a common problem during drilling operations in the Longmaxi shale formation, which vastly restricts drilling efficiency and shale gas development. For a horizontal well in particular, the long period of drilling increases the possibility of collapse. The central reason for the frequent wellbore collapses in shale formations is that shale has abundant planes of weakness, that is, bedding planes and fracture planes. These weak planes reduce shale strength and increase the anisotropy of the shale, complicating the wellbore instability issue. Therefore, this paper extends results of previous work and presents an attempt to establish a new model to investigate the influence of multiple groups of weak planes on wellbore stability in shale formation. By using this model, the influences of weak planes on stress distribution and shale strength are analysed respectively. It is shown that the anisotropy of shale formation makes stress distribution variable. Besides, the presence of weak planes decreases shale strength and this reduction of strength becomes larger with the increasing number of groups of weak planes. In particular, with more than four groups of weak planes, shale strength is entirely controlled by the weak plane. Based on the analysis of shale strength and effective stress at the wall of borehole, the investigation on influence factors of wellbore stability in shale formation has been conducted. The results indicate that collapse pressure has increment with increasing anisotropy of shale formation. Additionally, different occurrence and number of weak planes cause variation in collapse pressure. For a horizontal well, the selection of appropriate drilling azimuths can reduce the effect of weak planes on the borehole. The interaction between drilling fluid and shale leads to incremental collapse pressure, and this increment is higher in the multiple groups of weak planes and strong anisotropy condition. Finally, this model was applied to a field case in the southern Sichuan Basin,