

Comparison of the AE monitoring results between the hydraulic fracturing and SC-CO₂ fracturing

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Introduction

Non-aqueous fracturing technology supercritical (SC)-CO₂ fracturing has attracted much attention from the unconventional oil and gas reservoir reconstruction technology area^[1]. Many research results getting from field and laboratory showed that fracturing initiation pressure decreased a lot when the SC-CO₂ was used as fracturing fluid ^[2-3]. However, due to SC-CO₂'s strong filtration characteristics, it will be rapidly lost after cracks opening. Therefore, whether SC-CO₂ fracturing can improve the SRV (simulated reservoir volume) of reservoirs or not needs a further study. In this paper, acoustic emission (AE) was used to monitor true tri-axial fracturing experiments, to explain the effect of SC-CO₂ on fracturing. And then we compared AE monitoring results of the SC-CO₂ and the hydraulic fracturing. AE was used to explore the mechanism of the SC-CO₂ fracturing.

Methodology

Samples are shale outcrops of the Longmaxi formation in Sichuan Province. They have mature bedding structures, and their matrix parts are tight with low permeability. 16 AE monitoring channels are used in the true tri-axial fracturing experiments. AE waveform sequence, AE parameters, AE hypocenter locations and moment tensors are used to analyse the fracturing process.

Results

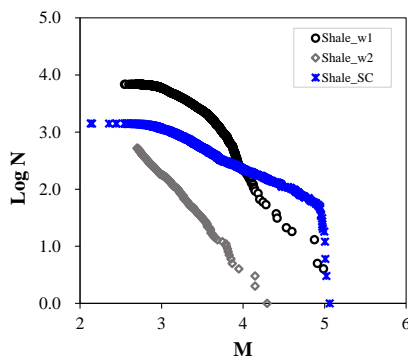


Figure.1 AE amplitude distributions of the three samples

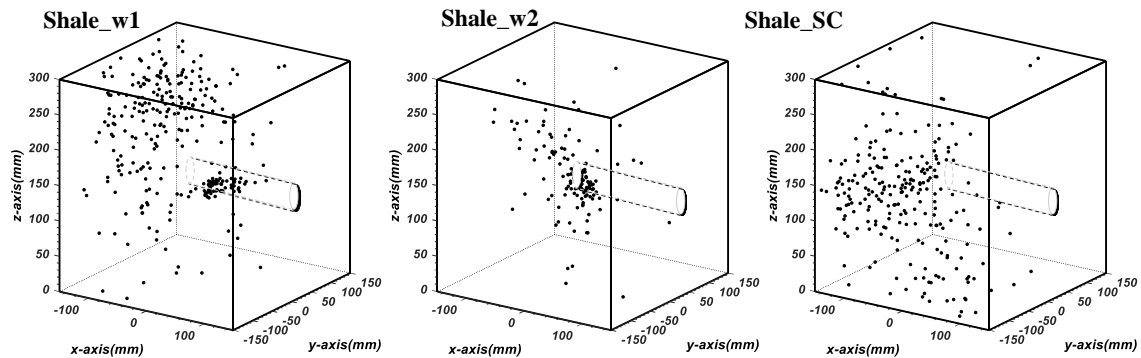


Figure.2 AE hypocenters locations of the three samples

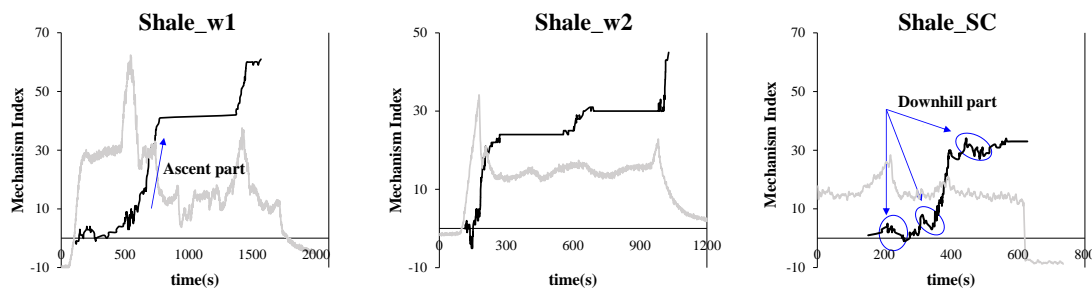


Fig.3 AE hypocenters mechanism index curves (the grey curves are the injection stress curves as a background)

Discussion

Results (Fig. 1) show that in the SC-CO₂ fracturing (Shale_SC), the total number of AE events is small, the duration time of the fracturing is short, high-energy AE events account for a large proportion of the whole events, and b-value is low. Comparing with the hydraulic fracturing (Shale_w1, Shale_w2), hypocenters location results of the Shale_SC getting from double-difference algorithm^[3] show that hypocenters near the wellhead are not concentrated, their spatial distribution is dispersed, and the distribution in the direction that perpendicular to the bedding is narrow (Fig.2). Moment tensor decomposition^[4] (decomposed into ISO, CLVD and DC components) results (Fig.3) show SC-CO₂ can induce more shear cracks during the crack initiation process, but more tensile cracks generated during the crack propagation process.

Conclusions

These results provide a basis for hydraulic fracturing mechanics theoretical research. For Sichuan Longmaxi shale, although SC-CO₂ can reduce the fracture initiation pressure and shorten the fracturing time, it doesn't achieve an ideal connection between layers and a better SRV.

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