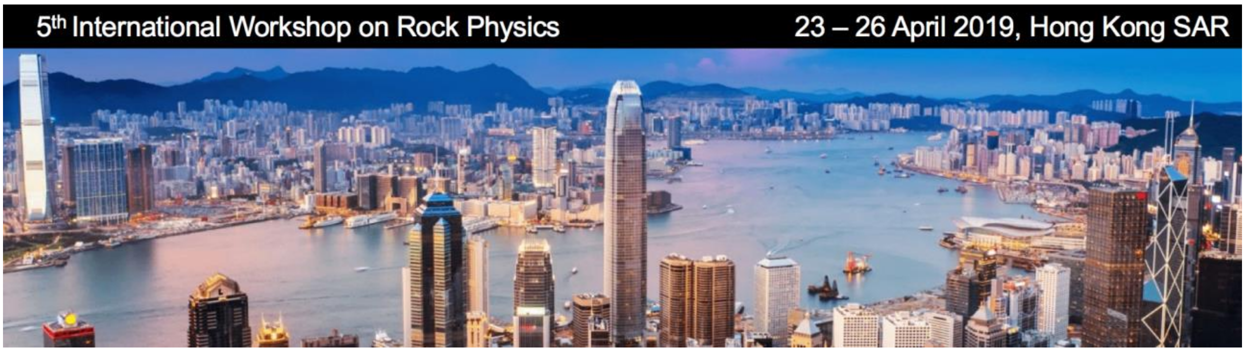

Experimental Study of the Velocity Anisotropy and Its Affection Factors in Tight Reservoirs

Qian Zhang[a], Xiaoqiong Wang[a], Hongkui Ge [a], Long Chang [a]. Shan Wu[a]. and Yueyue Sun[a]

[a] *China University of Petroleum Beijing, The Unconventional Natural Gas Institute.*

Contact email: 15911151856@163.com

Introduction

Wave velocity and anisotropy play an important role in deep oil and gas exploration, reservoir evaluation and sweet spot prediction. Tight sandstone and shale have strong anisotropy due to the development of bedding, the orientation of mineral and the development of natural fractures.

Methodology

Recently, the studies about anisotropy of tight reservoir and its influence factors are relatively rare. Therefore, in this study, we chose samples from four different tight reservoirs, carried out the experimental study of velocities anisotropy, electron microprobe imaging and wave velocity stress sensitivity, analyzed the main influential factors and the law of anisotropy in tight sandstone and shale.

Results

Results firstly show that bedding is the main influencing factor for the anisotropy of tight sandstones, while the anisotropy of shale is mainly caused by the orientation of microcracks. Secondly, the rock wave velocity in the parallel direction to the bedding is higher than the wave vertical to the bedding direction, and the ultrasonic velocity increases with the stress increasing. Thirdly, the velocity anisotropy of tight rock samples varying with the increase of the stress. This change is mainly divided into two stages: In the first stage The wave velocity anisotropy becomes weak with the increase of stress, In the second stage, the wave velocity anisotropy remains stable with stress loading, with little or no change. According to the analysing of electron microprobe imaging and the change of velocity, these two stages are mainly related to microcrack porosity and clay mineral content.

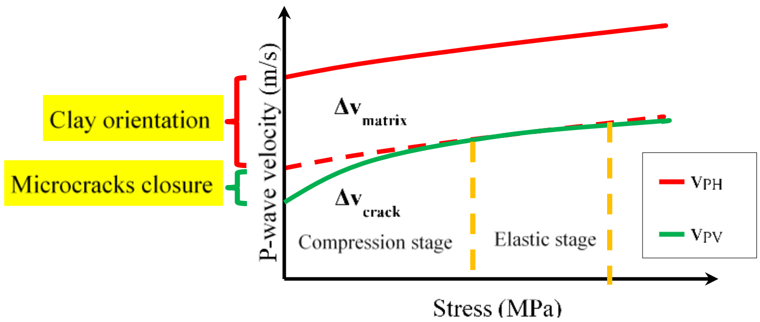

Figure 1: model for differentiating cracks and clay with velocity anisotropy

Discussion

In the first stage of the loading, the change of the velocity (Δv_{crack}) is related to the orientation microcracks. With the increasing stress, microcracks are gradually closing, which impair the anisotropy of the rock. Results show that there are good linear relationships between Δv_{crack} and microcrack porosity, the correlation coefficient of Δv_{crack} and microcrack porosity is greater than 0.99. the anisotropy caused by crack named stress anisotropy. In the second stage. The anisotropy coefficient linearly related to the clay mineral content in the tight reservoir core, which called material anisotropy, the correlation coefficient is greater than 0.99, indicating that the anisotropy at this stage is mainly attributed to the qualitative arrangement of clay mineral.

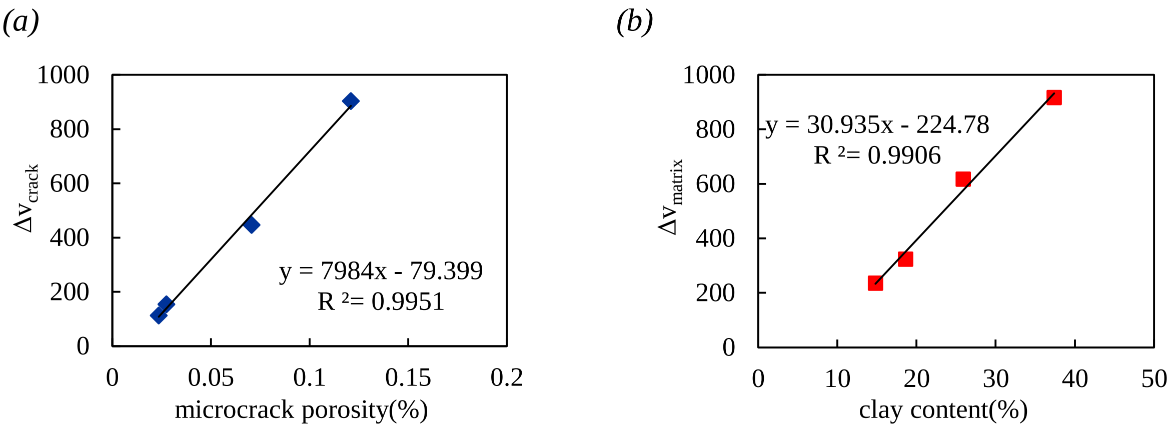

Figure 2: (a) Correlation between microcrack porosity and Δv_{crack} *(b) Correlation between clay content and* Δv_{matrix}

Conclusions

The results indicate two stages in which the acoustic velocities change with the stresses. According to these two stages, the influence of cracks and the matrix on rock anisotropy can be quantitatively distinguished, the proportion of stress anisotropy and the material anisotropy in the whole anisotropy of rock can be determined. These analysis results have direct reference value for fracture expansion prediction and microseismic monitor in volumetric fracturing.

Acknowledgements

This work was supported by the Joint Funds of the National Natural Science Foundation of China (Grant No. U1562215), and the National Basic Research Program of China (Grant No. 2015CB250903)

References

Song L T, Liu Z H, Zhou C C, et al. Analysis of elastic anisotropy of tight sandstone and the influential factors[J]. Applied Geophysics, 2017, 14(1):10-20.

Dewhurst D N, Siggins A F. Impact of fabric, microcracks and stress field on shale anisotropy[J]. Geophysical Journal of the Royal Astronomical Society, 2010, 165(1):135-148.

Bin L Kern H. Anisotropy of poisson's ratio in rock samples under confining pressures. [J]. Chinese Journal of Geophysics, 2002, 45(6):880-890.