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Estimation of brittleness index using dynamic and static elastic constants in the Haenam Basin, Southwestern Part of Korean Peninsula

Seho Hwang (1), Jehyun Shin (1), Jongman Kim (1), Byeongho Won (1), Wonkyoung Song (1), Changryol Kim (1), and Jungseok Ki (2)

(1) Korea Institute of Geoscience and Mineral Resources, Geologic Environment Division, Daejeon, Korea (hwangse@kigam.re.kr), (2) GeoScan Co., Ltd, #105 Gwanyang Doosan Venture Digm, 250 Hakeui-ro, Dongan-gu, Anyang-si, Gyeonggi-do 431-060 , Korea

One of the most important physical properties is the measurement of the elastic constants of the formation in the evaluation of shale gas. Normally the elastic constants by geophysical well logging and the laboratory test are used in the design of hydraulic fracturing . The three inches diameter borehole of the depth of 505 m for the evaluation of shale gas drilled and was fully cored at the Haenan Basin, southwestern part of Korea Peninsula. We performed a various laboratory tests and geophysical well logging using slime hole logging system. Geophysical well logs include the radioactive logs such as natural gamma log, density log and neutron log, and monopole and dipole sonic log, and image logs. Laboratory tests are the axial compression test, elastic wave velocities and density, and static elastic constants measurements for 21 shale and sandstone cores. We analyzed the relationships between the physical properties by well logs and laboratory test as well as static elastic constants by laboratory tests. In the case of an sonic log using a monopole source of main frequency 23 kHz, measuring P-wave velocity was performed reliably. When using the dipole excitation of low frequency, the signal to noise ratio of the measured shear wave was very low. But when measuring using time mode in a predetermined depth, the signal to noise ratio of measured data relatively improved to discriminate the shear wave. P-wave velocities by laboratory test and sonic logging agreed well overall, but S-wave velocities didn't. The reason for the discrepancy between the laboratory test and sonic log is mainly the low signal to noise ratio of sonic log data by low frequency dipole source, and measuring S-wave in the small diameter borehole is still challenge. The relationship between the P-wave velocity and two dynamic elastic constants, Young's modulus and Poisson's ratio, shows a good correlation. And the relationship between the static elastic constants and dynamic elastic constants also shows a good correlation. The estimation of brittleness index using averaging the dynamic and static elastic constants shows the good trend, i.e. as Poisson's ratio decreases, Young's modulus increases. From the various tests such as well logging in the pilot borehole and laboratory test, we could understand the key to accurately predict the brittleness index is the measurement of S-wave velocity using dipole sonic log.