Horizontal Stress Prediction Using Seismic Velocities Based on Convolutional Neural Network

Fatemeh Saberi[1], Esmael Makarian[2], Ayub Elyasi[3], and Tomomewo Stanley Olusegun[1]

[1]University of North Dakota
[2]Sahand University of Technology
[3]CAPE Consultant Group

Abstract

In all underground surveys, determining different types of stress is vital, not the least of which is horizontal stress (HS), which consists of minimum and maximum (Sh_{min} & Sh_{max}, respectively). In order to identify these parameters, a myriad of direct and indirect methods has been provided. Since they may need to take a lot of time and money, or employing them in some situations is impossible or difficult, such as weak formations, this study strives to estimate Sh_{min} and Sh_{max} using new technology in data science fast and accurately. The study area is in a carbonate formation with a thickness of about 300 m. For this purpose, input data, including Compressional and shear velocities (VP & VS) obtained from a well-logging operation, was processed in the first step. Then, a deep learning method called Convolutional Neural Network (CNN) was employed to predict the HS by the input data. Finally, the obtained results were evaluated through ten different statistical benchmarks. According to the results, CNN could predict Sh_{min} with r=0.93 and R^2=0.86, and the root mean square error (RMSE) is 4.6. CNN performed similarly to calculated Sh_{max} with r=0.92, R^2=0.85, and RMSE = 3.73. Other statistical analyses of results illustrated that seismic velocities could be considered a reliable anchor to predict HS.