Combination effects of temperature and pressure on the petrophysical properties of bitumen-bearing carbonate rocks: insight for the Majella reservoir (Italy)

Roberta Ruggieri and Fabio Trippetta
Università di Roma Sapienza, Earth Sciences, Roma, Italy

Unconventional oils are emerging as an alternative hydrocarbon reserve since conventional oil is depleting nowadays. A kind of unconventional oil is bitumen, which is characterized by high density, high viscosity and API gravity less than 10° and these physical properties are temperature sensitive. Therefore, an accurate assessment of variation in petrophysical properties of bitumen as a function of temperature and pressure is interesting in oil exploration industry.

In this work we investigated the role of heavy hydrocarbons (HHC) in changing petrophysical properties of carbonate-bearing rocks of the Majella reservoir performing seismic wave velocity measurements at increasing temperature. The investigated lithology belongs to the Bolognano formation that outcrops naturally in saturated and unsaturated conditions in the northwest sector of Majella Mountain (in Central Italy).

We conducted ultrasonic measurements of compressional and shear wave velocities on HHC-bearing carbonate samples showing different bitumen content and porosity between 10% and 19%. Firstly, we characterized bitumen density by HCl dissolution of the hosting rock, that resulted to be included between 1.14 and 1.26 gr/cm$^3$ at ambient temperature. Then, we calculated HHC content of our samples, spanning from 2% (low HHC-bearing sample) to 16% (high HHC-bearing sample). Our acoustic velocities point out an inverse relationship with temperature. P- and S-wave velocities depict a distinct trend with increasing temperature depending on the amount of HHC content. Indeed, samples with the highest HHC content show a larger gradient of velocity changes in the temperature range of about 60°-50° C, suggesting that bitumen can be in a fluid state. Conversely, below about 50° C the velocity gradient is lower because, at this temperature, bitumen can change its phase in a solid state. Currently, we are analysing the coupling effect of temperature and pressure on HHC-bearing carbonate samples to test the acoustic response of the investigated samples simulating the reservoir conditions.

Our preliminary results highlight a strongly temperature dependence for HHC-bearing carbonate properties and bitumen influences the acoustic response of carbonate rocks. Such petrophysical characterization would provide a better link between seismic parameters and the hydrocarbon properties with important implications for reservoir characterization from seismic data and for production monitoring.