Petroleum Research

Petroleum Research 2018 (April -May), Vol. 28, No. 98. 53-57

DOI: 10.22078/pr.2017.2688.2238

Relationship Between Grain Size and Physical Properties of Dolomites in Order to Geomechanics Study of Dolomite Reservoirs

Ali Lakirouhani [1]* Farhad Asemi[2] and Afshin Zohdi[3]

1. Department of Civil Engineering, University of Zanjan, Zanjan, Iran

2. Department of Civil Engineering, University of Zanjan, Zanjan, Iran

3. Department of Geology, University of Zanjan, Zanjan, Iran

rou001@znu.ac.ir

Received: May/2/2017 Accepted: October/30/2017

Abstract

Based on the extensive studies which have been done, undoubtedly, the role of the wave velocity data of rocks in hydrocarbon reservoir evaluation is absolutely vital. Within, it is important to study the wave velocities in the Dolomites, which often make up one of the best parts of hydrocarbon reservoirs in the carbonate system. Certainly, the texture of rocks, mineralogical composition, grain size, percent of quartz in rocks, and many microstructure properties affect the Engineering and Physical Behavior of rocks. According with previous studies and to better understanding this relationship, a comprehensive program of tests on the three categories of dolomite with fine, medium and coarse grained were designed. In this paper, the results related to the measurement of compressive (V_p) and shear wave velocity (V_s) for 32 samples are given. According to the results, with increasing in grain size, density of rock decreases. The compressive and shear wave velocity for fine grain and coarse grain samples were found to be 9% and 12% lower, respectively, than those for the medium grain samples. The results showed that for fine, medium and coarse grain samples; moreover, the ratio of V_p/V_s is 1.81 ,1.78, and 1.77 respectively. It was also observed that the dynamic Young modulus for the medium grain samples approximately 15% of the fine grain samples, and approximately 27% of the coarse grain samples is more. In addition, it was found that a significant change does not occur in Poisson’s ratio of the studied rocks with an increase in grain size.

Keywords: Dolomite, Grain Size, Compressive and Shear Wave Velocity, Dynamic Elastic Constants, Soltanieh and Elika Formations.

Introduction

About 80% of the oil and gas reservoirs in North American carbonate rocks are in dolomites and up to 50% of the world's carbonate reservoirs are dolomites. Significant proportions of the hydrocarbons in the former Soviet Union, northwestern and southern Europe, north and west Africa, the Middle East, and the Far Fast are also found in dolomite reservoirs. In Iran, the parts of the reservoir of Asmari, Jahrom, and Mozduran Formations are formed by dolomite layers. Also, the major part of the reservoir rock of Nar, Kangan, Aghar and Pars fields is dolomitic rocks. In recent years, the determination of the physical and mechanical properties of rocks and their relationship with the microstructure characteristics has attracted many researchers in the field of rock mechanics. The microstructural properties can be represented by mineral characteristics, and the type, size, shape, orientation, interlocking, distribution of mineral grains.

Wave propagation through rock is an important part of subjects such as rock mechanics, rock engineering, geophysics and seismology. In many rock mechanics projects, shear wave velocity are used as a tool to provide information about properties or to break the rock. Also, determining the shear wave velocity plays a key role in obtaining a clearer view of the reservoir, and as a result of making the right decisions in the various phases of exploration and production. The ultrasonic wave velocity in rock sample is related to its microstructure properties, such as mineralogical composition, grain size, percentage of quartz in rocks. In recent years, the relationship between the grain size of rocks and their physical properties, such as the density and the wave velocity, has been considered by many researchers. However, due to the existence and effectiveness of other parameters in them, the results obtained by different researchers are not the same and there is still no comprehensive relationship that can be attributed to all types of rocks.

The purpose of this paper is to study the effect of grain size on physical properties of dolomite in northwestern of Iran.

Methodology

After assessing satellite and geological maps it was determined that two rock formations were suitable for sampling; Soltanieh and Elika Formation; in Zanjan province, northwestern of Iran. Three kinds of dolomite with similar mineralogical compositions were selected; fine grain, medium grain and coarse grain. Compressive and shear wave velocity were measured by separated transducers using a sonic viewer device. Also, according to the results of wave crossing velocity experiments, dynamic elastic constants (dynamic Young's modulus and Poisson's ratio) were calculated for the rock samples.

Geological setting of area of study

The Soltanieh Formation is expanded to late Precambrian- early Cambrian age in the Alborz Sedimentary Basin (specifically in west and central areas) in almost 500 Km. Hamdi (1989) has divided the Soltanieh Formation into five lithological horizons including: lower dolomite, lower shale, middle dolomite, upper shale and upper dolomite [1]. In the study area, based on studies conducted by Zohdi et al. (2017), Soltanieh Formation is composed of seven parts consisting of five parts of dolomite and two parts of shale [2].

Petrographic and mineralogical analysis

In order to classify samples a compilation of classification procedures Gregg and Sibely (1984), Sibely and Gregg (1987) and Mazzullo (1992) was used [3-5]. In the following description of three type of dolomites is presented:

Fine grain dolomite

According to petrographic studies, dolomite type I (fine grain dolomite) is made of anhedral very fine grains to fine grains with intergranular boundary of non-planer. Size of dolomite grains in this group is smaller than 20 microns (9 micron on an average) and distribution of grain size is uniform in them (Fig. 1).

Medium grain dolomite

Type II dolomites mainly consist of dense and subhedral grains and also intergranular boundaries of planer-s. The size of grains in this type of dolomite varies between 20 to 100 microns (42 microns on an average) (Fig. 1).

Coarse grain dolomite

Type III dolomites have grains between 100 to 500 microns (120 microns on an average). This type of dolomite is made of dense coarse-grained mosaics, subhedral and having non-uniform distribution size (Fig. 1).

Discussion and Results

Results showed that with increase in grain size, density decreases (Fig. 2c). Also even though the three rock groups are similar based on mineralogical composition, but it was observed that compressive and shear wave velocity for medium-grained samples is almost 9 percent and is almost 12 percent more than coarse grain samples (Fig. 2d, e). Even though coarse-grained dolomites have the least density but compressive and shear wave velocity in them is near fine-grained dolomite. Basically, with increase in grain size of rock which induce decrease in grain boundaries in an obvious volume, wave velocity decreases. Observed result in current study can be related to non-uniform distribution of grain size in medium-grained and coarse-grained dolomites and in fact be related to big crystals existing in them.

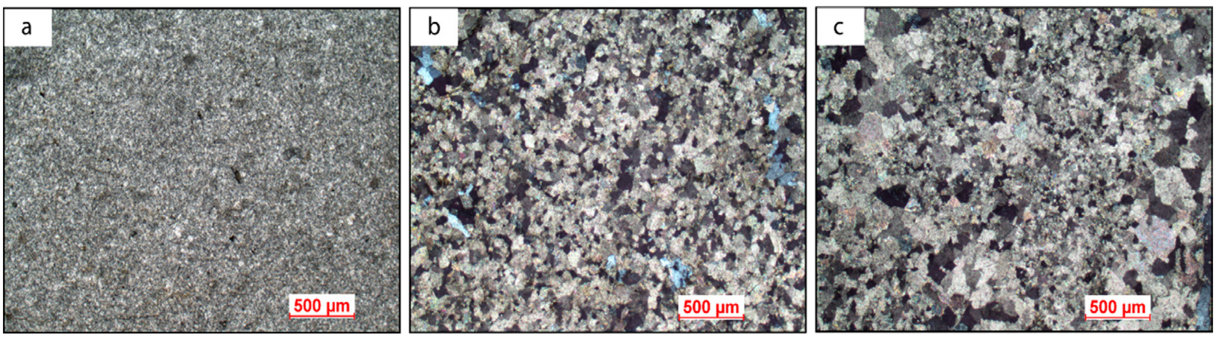

Figure 1: Different types of studied dolomite. (a) Fine grain dolomite and (b) Medium grain dolomite and (c) Coarse grain dolomite from the Soltanieh and Elika Formation

Petroleum Research, 2018(April -May), Vol. 28, No. 98

In this study correlation relationship between compressive and shear wave velocity for studied dolomite rocks was calculated according to equation 1:

During previous years a large number of studies have been conducted in relation to measure shear wave velocity from compressive wave. In 1985, Castagna et al presented some experimental relationships by using multi degree regression based on core data and well depictions based on different type of rocks to estimate the shear wave velocity [6]. Also Pickett in 1963 based on conducted experimental studies on carbonate tanks achieved the result that shear wave velocity in different rocks is a constant coefficient of wave compressive wave velocity. He presented the ratio of compressive to shear wave velocity for dolomite rocks and limestones as 1.8 and 1.9 respectively [7]. In this research this ratio for fine-grained, medium-grained and coarse-grained dolomites achieved as 1.78, 1.81, and 1.77 respectively (Fig. 2d).

Conclusions

The purpose of this paper is to find the relationship between physical properties of Iran north-west dolomite rocks with grain size. According to the achieved results from conducted tests:

1- Density decreased with increasing grain size.

2- Evaluations for compressive and shear wave velocity for fine grain and coarse grain samples were found to be almost 9 percent and 12 percent lower respectively than those for the medium grain samples.

3- Ratio of compressive to shear wave velocity for fine grain, medium grain and coarse grain dolomite and averages of samples achieved as 1.78, 1.81, 1.77, and 1.79 respectively.

4- Dynamic young›s modulus for fine grain and coarse grain samples were found to be almost 15 percent and 27 percent lower respectively than those for the medium grain samples.

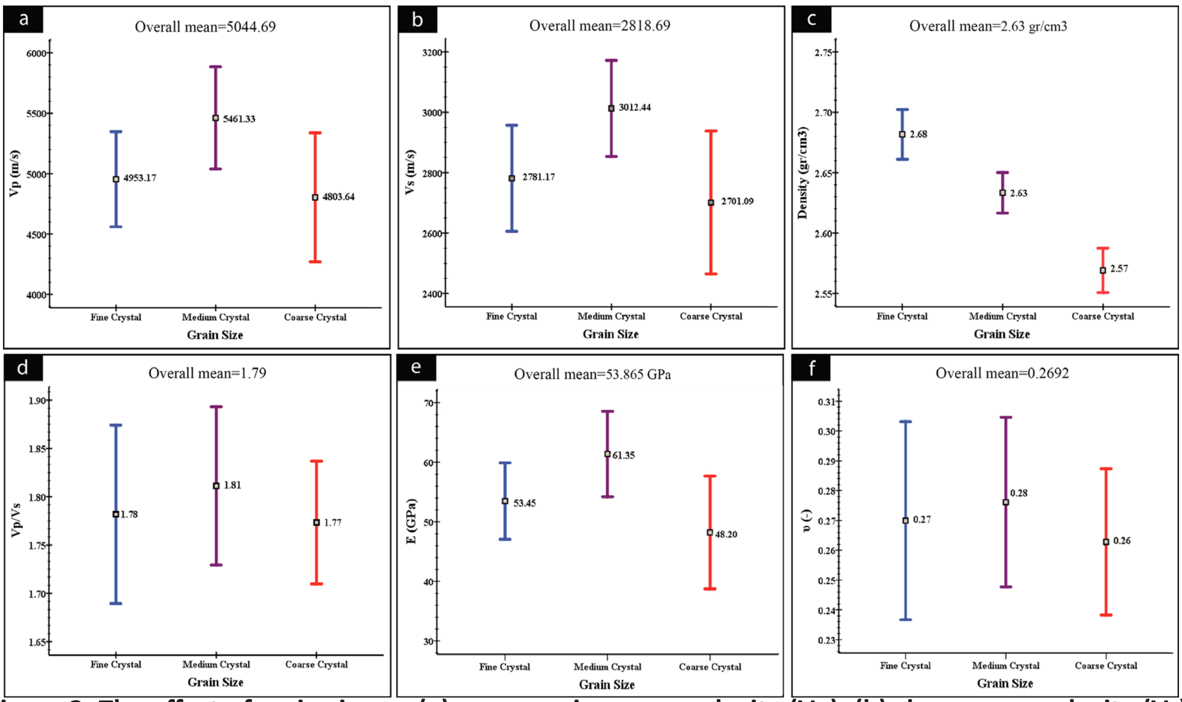

Figure 2: The effect of grain size on (a) compressive wave velocity (Vp), (b) shear wave velocity (Vs), (c) density, (d), Vp/Vs, (e) dynamic young›s modulus and (f) dynamic Poisson’s ratio

References

[1]. Hamdi B., "*Stratigraphy and paleontology of the late precambrian to early cambrian in the Alborz mountains Northern Iran*," Geological Survey of Iran, p. 41, 1989.

[2]. Zohdi A., Asemi F. and Lakirouhani A., "*Petrography and trace element geochemistry of dolomites in the Soltanieh Formation, SW Zanjan*," Proceeding of 35th national geosciences conference, Geological Survey of Iran, Tehran, Iran (in Farsi), 2017.

[3]. Gregg J. M. and Sibley D. F., "*Epigenetic dolomitization and the origin of xenotopic dolomite texture*," J. SEDIMENT RES., Vol. 54 (3), pp. 908-931, 2017.

[4]. Sibley D. F. and Gregg J. M., "*Classification of dolomite rock textures*," J. SEDIMENT RES., Vol. 5(6), 967-975, 1987.

[5]. Mazzullo S. J., "*Geochemical and neomorphic alteration of dolomite: a review*," Carbonate Evaporite, Vol. 7(1), pp. 21-37, 1992.

[6]. Castagna J. P., Batzle M. L. and Eastwood R. L. "*Relationship between compressional and shear wave velocities in silicate rocks*," Geophysics Vol. 50(4), pp. 571-581, 1985.

[7]. Pickett G. R., "*Acoustic character logs and their application in formation evaluation*," J. Petrol Technol. 15: 650-667. DOI: 10.2118/452-PA, 1963.