1. Research activity (max 1.000 words)

The study of fluid flows is one of the most investigated research fields due to numerous scientific and industrial applications. In fact, the implications of this project have a closely link with:

(1) earthquake field, because fluids play an important role in the faulting processes and during the seismic activity;

(2) oil and gas field. Fluid properties are of economic interest in the production of oil and gas, in the use of geothermal resources and in their exploration through the interpretation of seismic images.

Most of the present knowledge about porous rocks deformation mechanisms is based on laboratory studies carried out on dry samples (e.g. Lion et al., 2005; Mehrgini et al., 2016). However, in the upper crust the rocks are usually saturated by an interstitial fluid. Fluids influence the fracturing mode through physical and chemical interactions with matrix (e.g. dissolution). Moreover, fluids influence mechanical processes (e.g. De Paola et al., 2009; Mao et al., 2009) and petrophysical properties of rocks (e.g. Trippetta et al., 2010, 2013, Smeraglia et al., 2014). In addition, fluids migrate in time and space as highlighted by changes in the Vp/Vs ratio during seismic sequences (Chiarabba et al., 2009; Chiaraluce et al., 2011).

The influence of pressure and temperature on the mechanical properties of rocks has been proved by experimental studies conducted on various dry lithologies (e.g. Zharikov et al., 2000; Kitamura et al., 2006). The same tests were carried out on wet samples saturated with water clearly showing that the presence of the fluid reduces the resistance of the rocks (e.g. Wong et al., 2016). In such experiments, the influence of viscosity has been poorly investigated.

Moreover, the study about fluid viscosity is also crucial to overcome the difficulties of interpretation seismic images. These difficulties include the AVO attribute (Amplitude Variation with Offset), because we do not know fluid characteristics and how these affect the petrophysical properties of rocks.

Consequently, the goal of this research is to understand how fluid properties influence the mechanical and the acoustic behaviour of the rocks. Triaxial stress-cycling experiments will be conducted on carbonate samples with BRAVA at HP-HT Laboratory (INGV). During each

loading/unloading stress cycle, P and S wave velocities, permeability, strength and elastic moduli will be measured at different pore pressure and fluid viscosity. These experiments will be conducted on carbonates, which are the best lithology for both the earthquake and the oil & gas field.
Then, the experimental data will be applied at crustal scale developing models in order to improve the knowledge about crustal processes.

In conclusion, this study will lead to:

(1) define parameters that can be inserted into fracturing models;
(2) find the keys for a better interpretation of Vp/Vs variations at crustal scale;
(3) provide useful tools for the most correct interpretation of seismic images.

2. Research products

a) Publications (ISI journals)- Nessuna

b) Publications (NON ISI journals)- Nessuna

c) Manuscripts (submitted, in press)

- Lipparini L., Trippetta F., **Ruggieri R.**, Brandano M. & Romi A. - "3D oils distribution model in a porous-carbonate ramp reservoir, constrained by dense hystorical well data, field work and laboratory measurements (Maiella Mountain, Central Italy)". *APPG Bulletin* (in press).

d) Abstracts

- **Ruggieri R**., Trippetta F., Mollo S. & Lipparini L. "Influence of bitumen on the petrophysical properties of the Bolognano formation: a multidisciplinary approach applied to an area of the northern flank of Majella. *Abstract book, Società Geologica Italiana, Petroleum Geology Student Contest* (2017).
- Trippetta F., **Ruggieri R**., Geremia D., and Brandano M. "The influence of hydrocarbons in changing the mechanical and acoustic properties of a carbonate reservoir: implications of laboratory results on larger scale processes." EGU *General Assembly Conference Abstracts*. Vol.19 (2017).
- Trippetta F., **Ruggieri R**. & Lipparini L. "A multi-scale approach for understanding the role of hydrocarbons content on the mechanical properties of rocks: insights and implications for the Majella reservoir (Italy)." *Rendiconti della Società Geologica Italiana,* Suppl. N°1 Vol. 40 (2016).
- Lipparini L., Trippetta F., **Ruggieri R.**, Brandano M. & Romi A. "Densely spaced historic drilling data & modern 3D reservoir modelling of a carbonate oil field (Majella Mountain,Central Italy); heavy oil distribution and its

controlling factors." *Rendiconti della Società Geologica Italiana,* Suppl. N°1 Vol. 40 (2016).

- Lipparini L., **Ruggieri R.**, Brandano M., and Trippetta F. "Modelling of an outcropping heavy oil carbonate field, using dense well calibration, field work and lab measurements: the Oligo-Miocene reservoir of the Majella mountain – Central Apennines, Italy." *AAPG/SEG International Conference and Exhibition*, Barcelona, Spain, 3-6 April 2016.
- Trippetta F., **Ruggieri R**. & Lipparini L. "Variations of the petrophysical properties of rocks with increasing hydrocarbons content and their implications at larger scale: Insights from the Majella reservoir (Italy)." EGU *General Assembly Conference Abstracts*. Vol.18 (2016).
- Lipparini L., **Ruggieri R.**, Trippetta F., & Brandano M. "Unravelling Heavy Oil distribution and its controlling factors in a frozen oil field, through the use of multi-scale dataset: the Oligo-Miocene Carbonate Reservoir of the Majella Mountain (Central Apennines, Italy)". *Rendiconti della Società Geologica Italiana,* Suppl. N°1 Vol. 37 (2015).

N.B. I dottorandi del primo anno al punto 1 possono inserire il riassunto del progetto di ricerca (max 1.000 parole)