1. Research activity (max 1.000 words)

The link between fluids and hosting rocks plays a key role in many Earth's processes, such as faulting and migration of hydrocarbons. The general objective of this project is to define the coupling effects of petrophysical and mechanical properties of rocks and fluid properties at reservoir scale.

The assessment of how fluid properties, presence of fractures and faults influence hydrocarbon migration and entrapment is the specific goal of this research.

Consequently, the analysis on the influence of properties fluids and presence of fractures will lead to:

(1) define input parameters for earthquake nucleation models since fluid overpressure can facilitate fault slip;
(2) find the keys for a better interpretation of Vp variations during deformation processes;
(3) provide useful tools for controlling the oil migration in the petroleum system during production.

Reservoir characterization is an essential process to construct a quantitative representation of a reservoir incorporating all the characteristics of rocks to improve the hydrocarbon storage and production. During this process it is fundamental to investigate the key properties, such as porosity, permeability, fluid saturation and the fluid-rock interactions. Porosity is an important rock property because it is a measure of the potential storage volume of hydrocarbons. Permeability is a measure of the ease with which fluids can flow through the rock reservoir. Fluids influence the fracturing mode through physical and chemical interactions with matrix (e.g. dissolution), mechanical processes (De Paola et al., 2009; Mao et al., 2009) and petrophysical properties of rocks (Trippetta et al., 2013, 2020; Smeraglia et al., 2014).

In the last few years, carbonate rocks have received increasing attention because half of the known petroleum reserves occur within carbonate reservoirs, which likely contain faults and during modern energy production, faults can experience induced seismicity such as in Oklahoma (Keranen et al., 2014) and/or in Val D'Agri (Aydin, 2000; Improta et al., 2017). Furthermore, several geological field observations have documented that in carbonate fault zones it is possible to observe the presence of clay patches (Tesei et al., 2013; Collettini et al., 2019) that influence the fault-rock mechanical properties, such as slip behaviour and permeability (Faulkner and Rutter, 2000). Permeability is, also, affected by textural and hydraulic properties of the pore network, such as pore size distribution, pore shape, and tortuosity (Lucia, 2007) as well as heterogeneities such as faults.

Therefore, understanding how permeability is influenced by these different rock properties and its evolution during deformation processes is fundamental to predict the pathways and barriers for fluid flow within fractured reservoirs.

In order to constrain hydrogeologic models for fractured carbonate reservoirs, some laboratory and field studies are conducted to analyse permeability and deformation features that occurs in carbonate rocks (e.g., Tondi et al., 2006; Baud et al., 2009; Cilona et al., 2012, 2014).These authors highlighted that porous carbonates mainly showed homogenous deformation within ductile regime and the prevailing deformation mechanisms are microcracking and plastic/cataclastic pore collapse. Moreover, fractures and consequently permeability, in carbonate are particularly influenced by the high relative solubility of calcite, which drives the fracture mode in through mechanical, chemical and hydrogeological processes. In particular, permeability reduction is likely expected when the asperities are removed by stress-enhanced dissolution or by the reprecipitated secondary minerals (i.e., pressure solution). On the contrary, an increase in permeability may occur when a fracture void is etched by dissolution (free-face dissolution) (Ishibashi et al., 2013). All these processes, which affect positively or negatively permeability of carbonate rocks, are influenced by temperature, stress conditions and chemical composition of saturating fluid.

However, to date we have not yet clearly defined how the permeability in carbonate rocks evolves at arbitrary confining pressures and with reactive chemistry of the saturating fluid. Thus, more detailed experimental studies on carbonate rocks are necessary to better understand the factors that controls the permeability evolution during the deformation of porous carbonate rocks at different strain and pressure conditions. Simultaneously, it is crucial to investigate the evolution of ultrasonic velocities should be recorded in order to better identify how pore network modification is occurred.

2. Pubblications

Publications (ISI journals)

- Trippetta, F., **Ruggieri, R**., Brandano, M., & Giorgetti, C. (2019). Petrophysical properties of heavy oil-bearing carbonate rocks and their implications on petroleum system evolution: Insights from the Majella Massif. Marine and Petroleum Geology.

- Lipparini, L., Trippetta, F., **Ruggieri, R**., Brandano, M., & Romi, A. (2018). Oil distribution in outcropping carbonate-ramp reservoirs (Maiella Mountain, Central Italy): Three-dimensional models constrained by dense historical well data and laboratory measurements. AAPG Bulletin, 102(7), 1273-1298.

Abstracts

- **Ruggieri R**., Scuderi M., Tinti E., Trippetta F., Collettini C., Brignoli M., Mantica S., Petroselli S., Osculati L., and Volonté G. "Effects of illite content on frictional properties of experimental carbonate faults." EGU General Assembly Conference Abstracts. Vol. 21 (2019).

- **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, SGI, Petroleum Geology Student Contest (2017).

- Lipparini L., Trippetta F., **Ruggieri R**., Brandano M. & Romi A. "Densely spaced historic drilling data & modern 3D reservoir modelling of a carbonate oil field (Maiella Mountain, Central Italy); heavy

oil distribution and its controlling factors". Rendiconti della Società Geologica Italiana, Suppl. n° 1 Vol. 40 (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 Maiella Mountain (Central Apennines, Italy)". Rendiconti della Società Geologica Italiana, Suppl. n° 1 Vol. 37 (2015).