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# Structural setting of the Adriatic basin and the main related petroleum exploration plays

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ABSTRACT

Most of the oil and gas resources located within the Adriatic domain are genetically linked to the flexure of the Adria continental margin and to the evolution of the Apennines fold and thrust belt. The source rocks contained in the pre-flexure epi-continental successions reached the maturity window during the flexural subsidence or, alternatively, the flexural accommodating siliciclastic flysch themselves generated and stored hydrocarbons. The petroleum exploration plays of the Adriatic domain are tentatively classified in this paper, according to their geological evolution with respect to the Apennines fold and thrust belt.

The description of the geological evolution of these structures and related petroleum plays are described, including plays set in undeformed or poorly deformed foreland areas. A new isochrones map showing the structural setting of the substratum at the level of the Fucoidi Fm. is presented. Several different groups of structures can be recognized in the Adriatic domain, that can be connected to the final phases of deformation of the Apennines, or to the interaction with the Dinarides fold and thrust belt front to the east.



## 1. Introduction

A good variety of structural and stratigraphic plays occur in the Adriatic Sea, ranging from fault-related anticlines, developed in Plio-Miocene times, connected to the main Apennine thrust chain, and deeper carbonate structures developed in the south, to very shallow structure in Late Pliocene to Quaternary times in the central area.

Since the 1950's and increasingly in the last fifteen years, many papers concerning the geological evolution of the Adriatic Sea have been published, although few of them concerned to the hydrocarbon exploration (Pieri and Groppi, 1975; Royden et al., 1987; Zappaterra, 1990; De Alteriis, 1995; Ori et al., 1991; Argnani et al., 1997; Bertotti et al., 2001; Di Bucci and Mazzoli, 2002; Bigi et al., 2003; Battaglia et al., 2004; Ford, 2004; Zoetemeijer et al., 1993 among many others).

Papers dealing with petroleum systems (i.e. Anelli et al., 1996; Lindquist, 1999; Bertello et al., 2010), define mainly the conditions (e.g., reservoir, source rock, maturity, seal, etc.) that must coexist to generate a petroleum accumulation. Our approach is to illustrate the main petroleum plays in the central Adriatic domain, describing several different groups of structures defined with respect to their geological evolution within the Apennines fold and thrust belt, considering that the definition of a petroleum play should include both local field characters and the more general geological context. In this way, it should be possible to define a petroleum play referring not only to the source rock (i.e. Burano Petroleum System), but also to the different kind of hydrocarbon-bearing field structures and to their different ages. This work has the aim to provide a general picture of the geological setting of the most significant oil and gas fields of Adriatic domain, based on the geological relationships of the source rocks vs. the reservoir/trap.

## 2. Regional geological setting of the Adriatic domain

The Adriatic petroleum province belongs to the North African continental margin (Anderson, 1987; De Alteriis, 1995; Channel, 1996; Royden, 1988; Battaglia et al., 2004; Piccardi et al., 2011). Throughout the Mesozoic and the Early Paleogene the epi-continental sedimentation was predominantly carbonatic resulting from a complex paleogeographic configuration of indenting deep water basins and open shallow platforms.

In general the sedimentation was more continuous, but with low accretion rate, in the deep waters domains, and more

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discontinuous with long emersion/erosion periods (Albian, uppermost Cretaceous, Paleogene) and much higher rates in the carbonate shelf domains (Zappaterra, 1990; Casero and Roure, 1994). During Mesozoic times both extensional tectonic phases (i.e. Middle Liassic) and compressional paleoinversions (i.e. Lowermost Cretaceous) occurred (Ziegler, 1987; Ziegler et al., 1995). Moreover, Cretaceous basin sedimentation records pulses of accelerated subsidence (Marchegiani et al., 1999) that could be also related with Late Cretaceous extensional tectonics involving the carbonate platform domains (e.g. Shiner et al., 2004).

Starting from the Middle Eocene onwards the African continental margin was involved in the orogenic processes responsible for the development of the Alps and the Apennines (Doglioni, 1991; Bertotti et al., 2001; Faccenna et al., 2003; Doglioni et al., 2006; Patacca et al., 2008).

The flexure of the lithosphere belonging to the Adria margin started from the most internal areas and migrated eastward through time, forming foredeep basins oriented sub-parallel to the belts and filled by large quantities of terrigenous (siliciclastic) sediments, derived from the erosion of the incipient inverted margin (orogen and former foredeep). Each flexural phase was accommodated either by the sedimentation of a flysch wedge, or by the sub marine gravitational emplacement of large rock masses detached from the inverted margin sequence. This development has been extensively described by several authors, who highlighted the peculiar characteristics of the Apennines within the framework of the evolution of a foreland fold and thrust belt (Zoetemeijer et al., 1993; Ori et al., 1991; Patacca and Scandone, 1989; Mazzoli et al., 2001, 2005; Ford, 2004; Tozer et al., 2006; Patacca et al., 2008, among many others) (Fig. 1).

The Adriatic domain corresponds to the youngest part of the belt, strictly connected to the evolution of the Apennines fold and thrust belt and to the interaction with the Dinarides, which are subparallel orogenic belts with opposing vergences. Its development

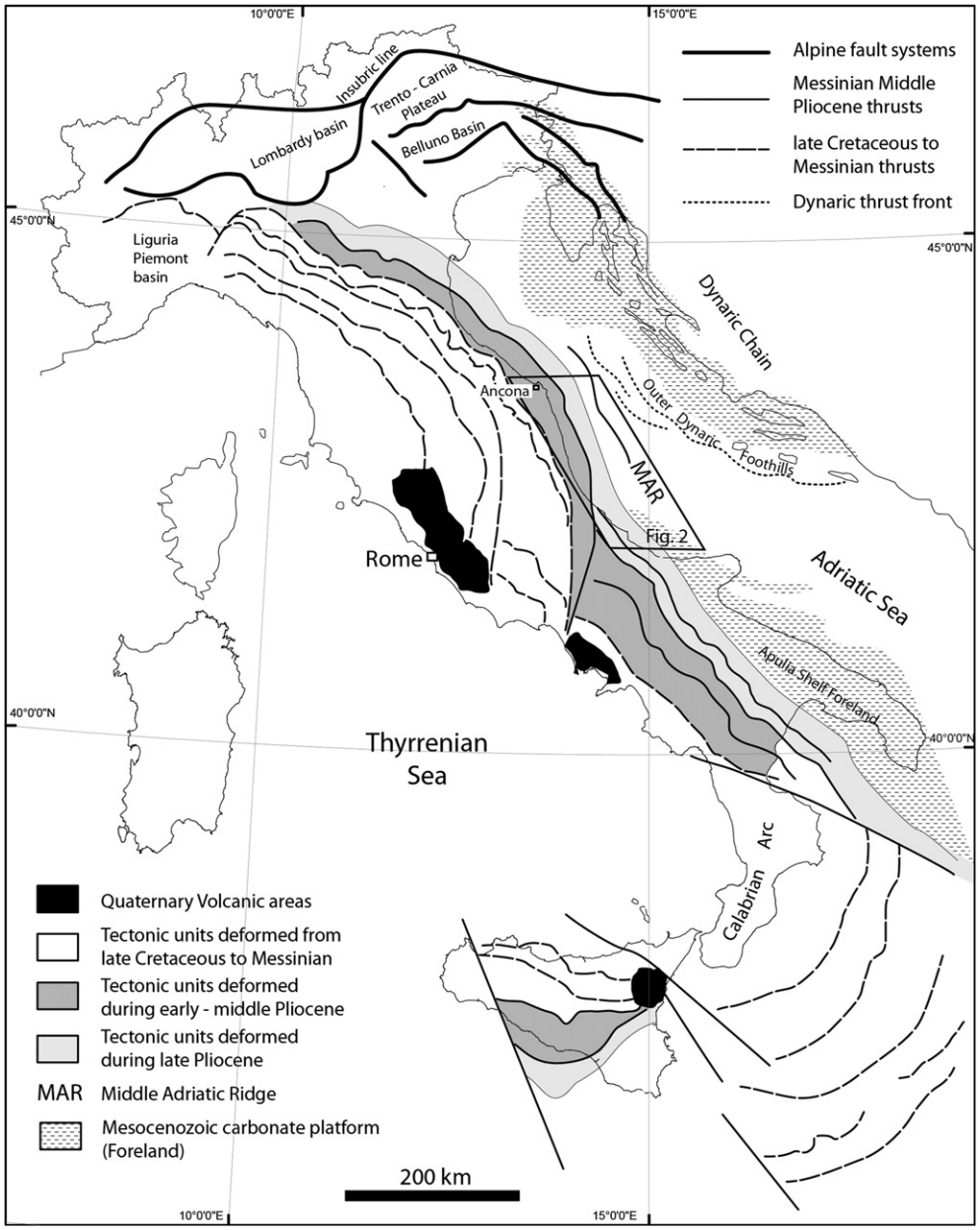


**Figure 1.** Kinematic model of the Apennines (modified from Casero, 2004). In the map are indicated the main tectonic units and the ages of the main thrust fronts.