# TECTONICS AND STRATIGRAPHY OF THE UMBRIA-MARCHES APENNINES, ITALY


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## INTRODUCTION

The 1995 Keck project in Italy investigated a variety of topics related to the tectonic and stratigraphic evolution of the Umbria-Marches Apennines, a Tertiary fold and thrust belt that forms the spine of the Italian peninsula. The stratigraphic sequence exposed in these mountains contains a detailed record of events related to a complete Wilson cycle of tectonics (Alvarez and Montanari, 1988), beginning with rifting and extension in the lower Jurassic, followed by compression related to a collision with Corsica and Sardinia in the Tertiary, and most recently, renewed extension. Because of the early extension and resulting subsidence, this region was a relatively deep water basin for most of its history, leading to a remarkably continuous sequence of pelagic sediments that contain an unparalleled record of Earth history (Alvarez and Montanari, 1988).

## JURASSIC EXTENSIONAL TECTONICS

One set of projects (Del Margo and Finn) addresses the structure and stratigraphy of the Jurassic portion of the sequence. The early Jurassic represents a major turning point in the development of this region as it changed from a shallow water carbonate platform depositional environment to one characterized by isolated carbonate seamounts and intervening basins up to a 1000 m deep. This change was the result of extension along a complex system of normal faults that broke up the pre-existing platform that covered most of Italy during the earliest Jurassic (Bice and Stewart, 1990). The break-up of the platform eventually led to the drowning of the platform and the entire basin sank to depths of around 2000 m by the mid-Cretaceous. It has often been suggested that these extensional structures played an important role in the later compressional deformation, but this question has not been addressed in this part of the Apennines because of the difficulty of precisely locating the older normal faults. Del Margo and Finn (this volume) combined efforts to locate these older structures and then evaluate their role in the compressional deformation.

## VOLCANIC ASH STRATIGRAPHY

The compressional deformation in the Apennines has been the source of some controversy, especially regarding the amount of shortening that has occurred (e.g., Bally et al, 1986). Montanari et al (1995) took the novel approach of studying grain size variations in a volcanic ash constrain the amount of shortening. There are a number of volcanic ashes within the Eocene-Pliocene part of this sequence; most of these ashes come from a small but potent volcanic arc on Sardinia, related to the subduction of the oceanic crust that formerly separated Italy from Corsica-Sardinia. Mt. Vesuvius is in the direction of these Sardinian volcanoes, and an historic eruption of Vesuvius provides a model for how grain size in an ash deposit varies with distance from the source. By comparing this model with the observed variations seen in a Miocene ash (which was involved in the folding and thrusting after it was deposited) that is exposed in many localities, Montanari et al (1995) were able to estimate the amount of shortening. Love and Fisk (this volume) attempted to extend this work, using other ash layers within this part of the sequence.

## MAGNETOSTRATIGRAPHY

These ash layers have provided critical radiometric calibration points that Montanari et al (1985) have used to develop a timescale for the Tertiary. These ashes provide the opportunity for direct dating of the magnetic polarity sequence. Curtis (this volume) extends the earlier work of Bice and Montanari (1988) and Lowrie and Lanci (1994), focusing on a complex part of the sequence that Bice and Montanari (1988) thought contained a very short reversal. The question of whether or not this reversal exists turns out to be important for theories that explain how magnetic reversals occur; one class of theories is incompatible with such short-lived magnetozones.

## CYCLOSTRATIGRAPHY

The portion of the Umbria-Marche sequence that represents the time between the Jurassic break-up and the Neogene folding and thrusting is also well known for the record of climate variations that are preserved in the form of stable isotope and also in the cyclic nature of sedimentation (e.g., Herbert and Fischer, 1986). Denman and Stanley (this volume) examined a portion of the Miocene section exposed along the Adriatic coast in order to better understand the cause of these cycles.

## MIO-PLIOCENE BASIN EVOLUTION

Although the part of the basin that is presently along the Adriatic coast was calm enough to record numerous climatic oscillations, folding and thrusting were occurring in the area 60 km to the west, near the Osservatorio Geologico di Coldigioco. By this time, the Alps were being eroded and the debris was funneled down into narrow submarine troughs following the front of the fold and thrust belt, depositing thick siliciclastic sediments that cap the Umbria-Marche sequence. Deposition in this part of the basin presumably represents a response to the history of folding and thrusting, and also the dramatic sea level change associated with the Messinian event, although very litle has previously been done on this part of the sequence. Boder, Dunlevy, and Gillis (this volume) studied various aspects of this Miocene and Pliocene sequence in order to better understand the timing of folding and thrusting as well as the overall basin development during this dynamic phase in basin's history.

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