Deep structure of Laga Basin

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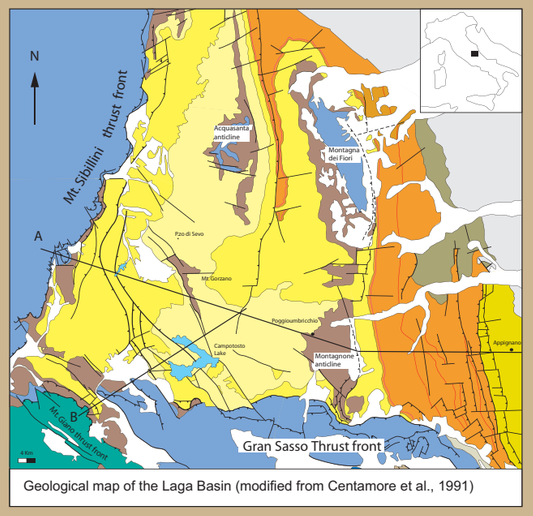
Introduction

The Laga Basin is considered one of the foredeep basin of Central Apennines, developed during Messinian time as a consequence of eastward migration of chain-foredeep-foreland system (Bigi et al., 1999). The present map pattern of Laga Basin has a triangle shape: the inner edge, to the west and to the south consists of two regionally important thrust fronts which are, respectively, the Mt. Sibillini thrust front, trending NE-SW and the Gran Sasso thrust front, trending E-W. Eastward, the Montagna dei Fiori-Montagnone anticline trends N-S (geological map of the area). In order to reconstruct the structural setting of this sector of the Apenninic chain, the area has been analyzed on seismic lines dataset (both confidential and public), calibrated by bore-hole data. 2D seismic datasets comprise profiles which are part of surveys made in 1983-1985, for a total length of about 400 Km. Based on these data, two geological cross sections (obtained by depth conversion of seismic profiles) and the contour map of structures reconstructed at the depth of Fucoidi Formation (Aptian-Albian) to illustrate thrust belt geometry are presented. This work is part of an integrated approach of the analysis of the Laga basin comprising thermal history and facies and physical stratigraphic analyses (Bigi et al. and Aldega et al., this poster section).



Geological map of the Laga Basin (modified from Centamore et al., 1991)

Legend

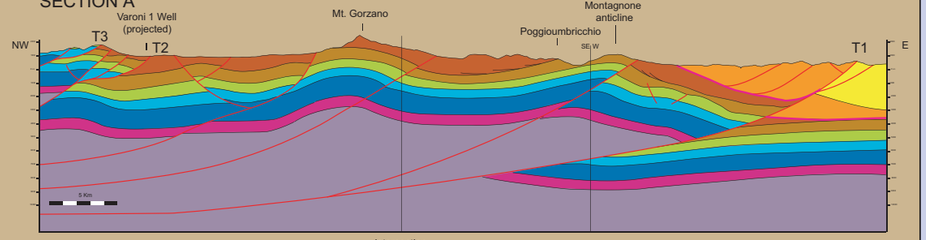
- Siliciclastic deposits (Middle Upper Pliocene)
- Marls and conglomerates (Marne del Vomano Formation Lower Pliocene)
- Cellino Formation (Lower Pliocene)
- Siliciclastic deposits a) volcanoclastic level (Upper Messinian)
- Gypsum arenites (Middle Messinian)
- Laga 2 sequence (Lower Messinian)
- Laga 1 sequence (Lower Messinian)
- Cerrogna Marls and Orbulina Marls Formation (Tortonian - Langhian)
- Umbria - Marche pelagic carbonate succession (Miocene p.p. - Triassic)
- Lazio-Abruzzi carbonate platform succession (Miocene p.p. - Triassic)
- thrust
- fault
- A — geological section trace

Stratigraphy

The Laga basin is filled by a siliciclastic turbiditic succession (Laga Formation, Messinian age, Centamore et al., 1991), onlapping onto the back limb of the Montagna dei Fiori-Montagnone anticline. This succession, largely cropping out in the study area, is crossed, tectonically repeated, for 1200 meters by Varoni 1 well and by Campotosto well for 1200 meters (see geological map for location and synthetic well log stratigraphy). In the eastern part of the basin, Lower Messinian deposits are covered by gypsum-arenites of Gessoso Solfifera Formation and by Upper Messinian-Lower Pliocene turbidites. The Lower Messinian deposits consists of two main fining-upward cycles (Allounits Laga 1 and Laga 2, see geological map) progressively shifting estward in a general progradational trend. These two allounits represents the fill and the overfill of a basin strongly controlled by thrusting activity (Bigi et al., 2006 this section). In the east of Montagna dei Fiori-Montagnone anticline these deposits reduce their thickness progressively on lapping on the top of Miocene hemipelagic deposits (Orbulina Marls Formation, Tortonian). This geometry is very well exposed on the western limb of Montagnone anticline (Poggioumbricchio) and is recognizable in depth in the seismic profiles, in the east of the same structure (cross section A).

Triassic–Miocene carbonates deposited in the Latium–Abruzzi platform (Bernoulli, 2001 and references therein) crop out in the south of the basin (Gran Sasso area), whereas the Umbria Marche pelagic succession (Santantonio, 1994 and references therein) widely outcrops in the hangingwall of the Mt. Sibillini thrust (T3), in the Montagna dei Fiori-Montagnone anticline and also constitutes the substratum of the Laga basin, as can be assessed from Varoni 1 and Campotosto 1 wells (geological map and well log stratigraphy).

SECTION A

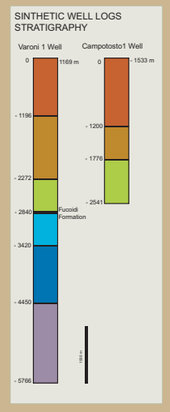


The deep structure of the basin

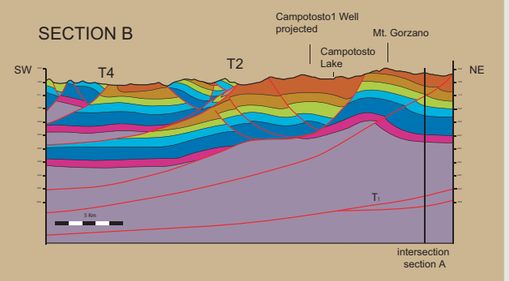
Based on the seismic profiles analysis two balanced geological cross section have been constructed: section A, from the Mt. Sibillini (T3 thrust) to Appignano and the section B from Mt.Giano (T4 thrust) to Mt.Gorzano-Acquasanta anticline (see geological map for location). The main thrust recognized is T1 thrust (section A). It produces an offset of about 10 Km, brings in the hangingwall a passively transported syncline involving Upper Messinian - Lower Pliocene deposits, and places the Messinian Laga basin domain onto the turbiditic siliciclastic deposits of Cellino Formation (Lower Pliocene) (Bigi et al., 1999; Albouy et al., 2003). The shifting of the depocenters from the Laga basin to the Cellino basin is due to the activity of this main regional thrust front, likely to be active starting at the end of the deposition of Laga succession (Laga 1 and 2). At regional scale, the T1 thrust trends mainly N-S and can be followed at the surface for about 100 Km from north to south.

The hanging wall of the T1 thrust constitutes the Laga domain and is characterized by several thrust planes: from east to west, they are the Gran Sasso thrust (T2), the Acquasanta thrust and the Montagna dei Fiori-Montagnone thrust, recognizable in both the cross sections.
In the northern sector the Acquasanta and the Montagna dei Fiori thrusts occur. Both of them have a N-S trend. The Acquasanta thrust is associated with a ramp anticlines showing a strong axial culmination in the north. Following the axial trend also the offset rapidly decrease along strike, and the thrust plane passes laterally to a simple anticline in the southern sector. The Montagna dei Fiori - Montagnone anticline trends N-S. The forelimb of the anticline is cut by the thrust plane producing a reduce offset, whereas the same homocline constitutes, in the east, the hanging wall of the T1 thrust (section A and time structure map). The anticline is cut by a normal fault dipping westward at the surface and is complicated at depth by a back thrust on the western limb.

SINTHETIC WELL LOGS STRATIGRAPHY



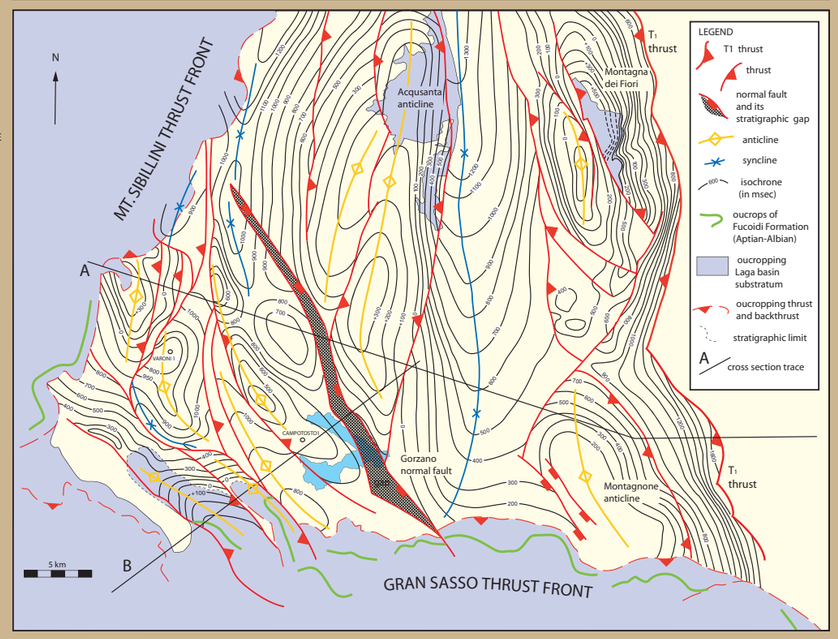
SECTION B



Legend of cross sections and well logs

- Cellino Formation (Lower Pliocene)
- Siliciclastic deposits (Upper Messinian)
- Gypsum arenites (Middle Messinian)
- Laga Formation (Lower Messinian)
- Cerrogna Marls and Orbulina Marls Formation (Tortonian - Langhian)
- Umbria-Marche pelagic succession (Oligocene - Upper Cretaceous)
- Umbria-Marche pelagic succession (Lower Cretaceous - Middle Lias)
- Massicio Formation (Lower Lias)
- Evaporites (Upper Triassic)
- Dolomites (Middle - Lower Triassic)
- thrust

SIMPLIFIED TIME STRUCTURE MAP FUCOIDI FORMATION (Aptian-Albian) - DP 200 m - variable replacement velocity (3200 - 4000 m/s)



The Gran Sasso thrust (T2) has been reconstructed in the whole area and well define in both the cross sections. Moving westward, the outcropping Gran Sasso thrust front, trending E-W, progressively rotates assuming a N-S trend as can be reconstructed based on seismic lines and surface structural trend. It consists of an high angle thrust plane, which progressively reduces its offset from south to north (T2 thrust, section A and B).
The hanging wall of T2 thrust is constituted by an array of outcropping anticlines and synclines involving the upper part of the carbonate and the Laga succession. These anticlines are associated to back thrust planes developed on their back-limb. Moreover the rotation of the fold axes is associated to the plunge northward of the anticlines outcropping in the south and southward of the anticlines outcropping in the north, creating a complicate interconnection of fold axes (see time structure map). This area involves in the deformation a reduced thickness of Laga 1 unit which suggests as this structures started their activity during the earlier phase of basin filling and allow to include the whole hanging wall of the Gran Sasso structure in the domain of the Laga Basin (see also Bigi et al, 2006, this poster section).
Shortening in the HW of T1 thrust (cross section A) is about 12% (L_0= 51 km and L_1= 45,5 km) and increases southward, where in section B is about 16% (L_0 = 74 km L_1 = 62 km). Shortening comprises the T1 thrust (section A) is about 20% (L_0= 145 km and L_1=116 km) which means that most of shortening is produced by the more external thrust in the northern area and that moving southward it is in part compensated by the Gran Sasso thrust (T2). T1 thrust geometry also suggests its activity is prolonged in time starting from Middle Messinian to Lower Pliocene.
The Mt. Gorzano normal fault is crossed by both the geological cross sections A and B. This fault has a normal offset of about 800-1000 m and show a listric geometry. The offset is balanced in the sedimentary succession by several thrust planes developed in its hanging wall.

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