# *Foredeep turbidites of the northern and central Apennines: Marnoso-arenacea and Laga Formations*

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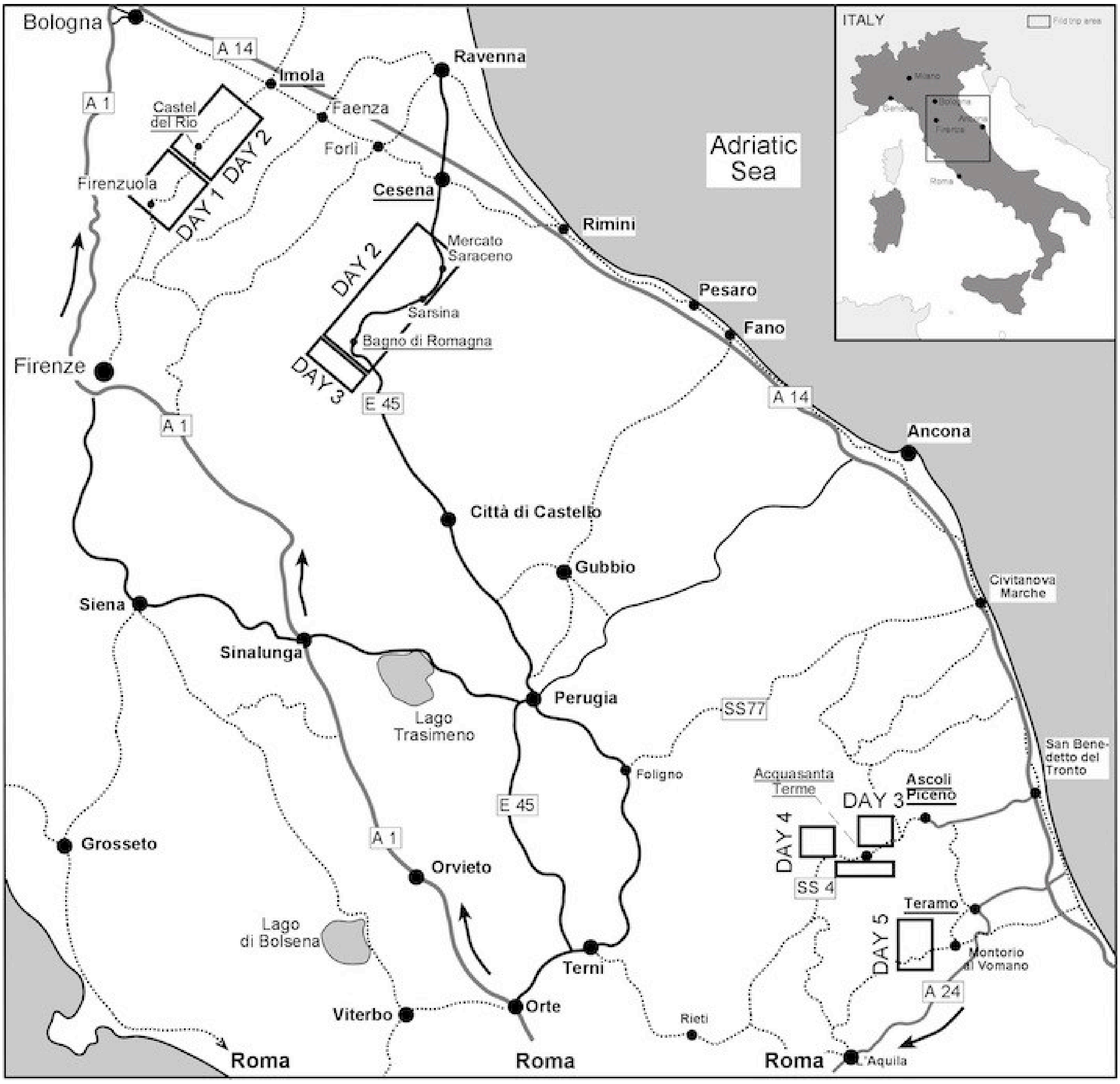
## TRIP ITINERARY




## Objectives and strategy

This field trip will provide to show the main facies and physical stratigraphic features of turbidite systems at different confining degree. We will discuss about the origin, provenance, and evolution of the turbidite flows as well as of the relationships between tectonics and sedimentation. Finally, the stratigraphic architecture of the Marnoso-arenacea and Laga basin will be discussed and framed in the context of the Miocene foreland basin system of the northern and central Apennines.

# *The lower-middle Messinian turbidite deposits of the Laga Basin (central Apennines, Italy)*

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## INTRODUCTION

Turbidite sedimentation occurs in different tectonic contexts, although the major fossil record of these deposits is preserved in the foreland basin systems. In such type of basins turbidite deposits coexist at different depth being located either in the more deeper portions (foredeep turbidite systems) or in the relatively shallower tectonically confined depressions occurring on top of the thrust belt (wedge-top turbidite systems) (see discussion in Mutti *et al*., 2002; 2003). The possibility to find both preserved and superimposed one to each other these turbidite systems is strictly related to progressive shifting of the main depocentres towards the foreland, a process that is essentially controlled by thrust propagation. This sedimentary evolution is well recorded by the Marnoso-areanacea (Ricci Lucchi, 1986; Roveri *et al*., 2002; Mutti *et al*., 2003; Tinterri and Muzzi Magalhaes, 2011), and the Lower Messinian Laga Formation (Milli *et al.*, 2007; 2009; Bigi *et al*., 2009; 2011; Marini *et al*., 2015; 2016), the deposits of which show many features indicating a sedimentation in a confined basin in which thrust propagation controlled shape, dimension and topography of the basin as well as the geometry of the deposits and the resulting facies.

## GEOLOGICAL AND STRATIGRAPHIC SETTING

The Laga Basin is located in the Central Apennines, which are part of a fold-and-thrust belt built up since the Late Oligocene in response to the subduction of the Adria micro-plate underneath the European Plate (Patacca *et al*., 1990; Carminati *et al*., 2004). Tectonic accretion and loading of the lithosphere in the Apennine subduction complex resulted in the development of an eastward migrating foreland basin system hosting the deposition of a number of major turbidite units (namely the Macigno, Cervarola-Falterona and Marnoso-arenacea Fms) younging toward the east (Ricci Lucchi, 1986) (Fig. 1a).

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In the late Miocene, the Marnoso-arenacea foreland basin system was broken up into several relatively small, wedge-top confined turbidite basins as a result of thrust-front propagation (Fig. 1a). Among these basins, the Southern Laga Basin (Fig. 1b) represented the largest turbidite depocentre hosting the deposition of more than 3000 m of turbidites of the Laga Formation (LateTortonian-Messinian; Centamore *et al*., 1991). Based on structural geology (Calamita *et al*., 1998; Artoni, 2003; 2013; Mazzoli *et al*., 2002; Albouy *et al*., 2003; Scisciani *et al*., 2001; Scisciani and Montefalcone, 2005; Bigi *et al*., 2009; 2011 with references therein), stratigraphy and sedimentology (Cantalamessa *et al*., 1986; Milli *et al*., 2007; 2009; 2013 with references therein) studies, the Laga Fm. has been recently subdivided into a number of informal stratigraphic units (Fig. 2) that can be correlated to the main regional events affecting the Mediterranean during the Messinian (see Manzi *et al*., 2013 with references therein). Age constraints for the Laga Fm. are provided by biostratigraphy of molluscs and foraminifera assemblages (Centamore *et al*., 1991) from the underlying and overlying deposits (the Pteropodi/Orbulina Marls Fms. and the Vomano Marls Fm., respectively) and the radiometric dating of a marker volcaniclastic layer (5.5 Ma; Bigazzi *et al*., 2000) found in the upper turbidites (Fig. 2). This field guide follows the stratigraphic nomenclature and interpretation of Milli *et al.* (2007; 2013) in subdividing the Laga Fm. into five low rank depositional sequences (*sensu* Catuneanu *et al.*, 2011) with time duration varying from 200 to 400 kyr (Fig. 2).

The first four of these sequences (Laga 1a-c and Laga 2 units) form a high rank composite sequence set named Laga Depositional Sequence (LDS; Late Tortonian-Lower Messinian) and interpreted as the latest stage of deposition within the Marnoso-arenacea foreland basin system (Milli *et al.*, 2007; 2013). Based on their internal architecture and spatial arrangement, these low rank units are organized to constitute the Lowstand (Laga 1a-b), the Transgressive (Laga 1c) and the Highstand (Laga 2) systems tracts of the LDS respectively (Fig. 3). The LDS crops out extensively in the western part of the basin (Fig. 1b) with a maximum thickness of 3000 m and thins rapidly toward the east and the south where it onlaps onto the pre-turbidite substrate. To the east of the Montagna dei Fiori-Montagnone Anticline, sparse outcrops and interpreted

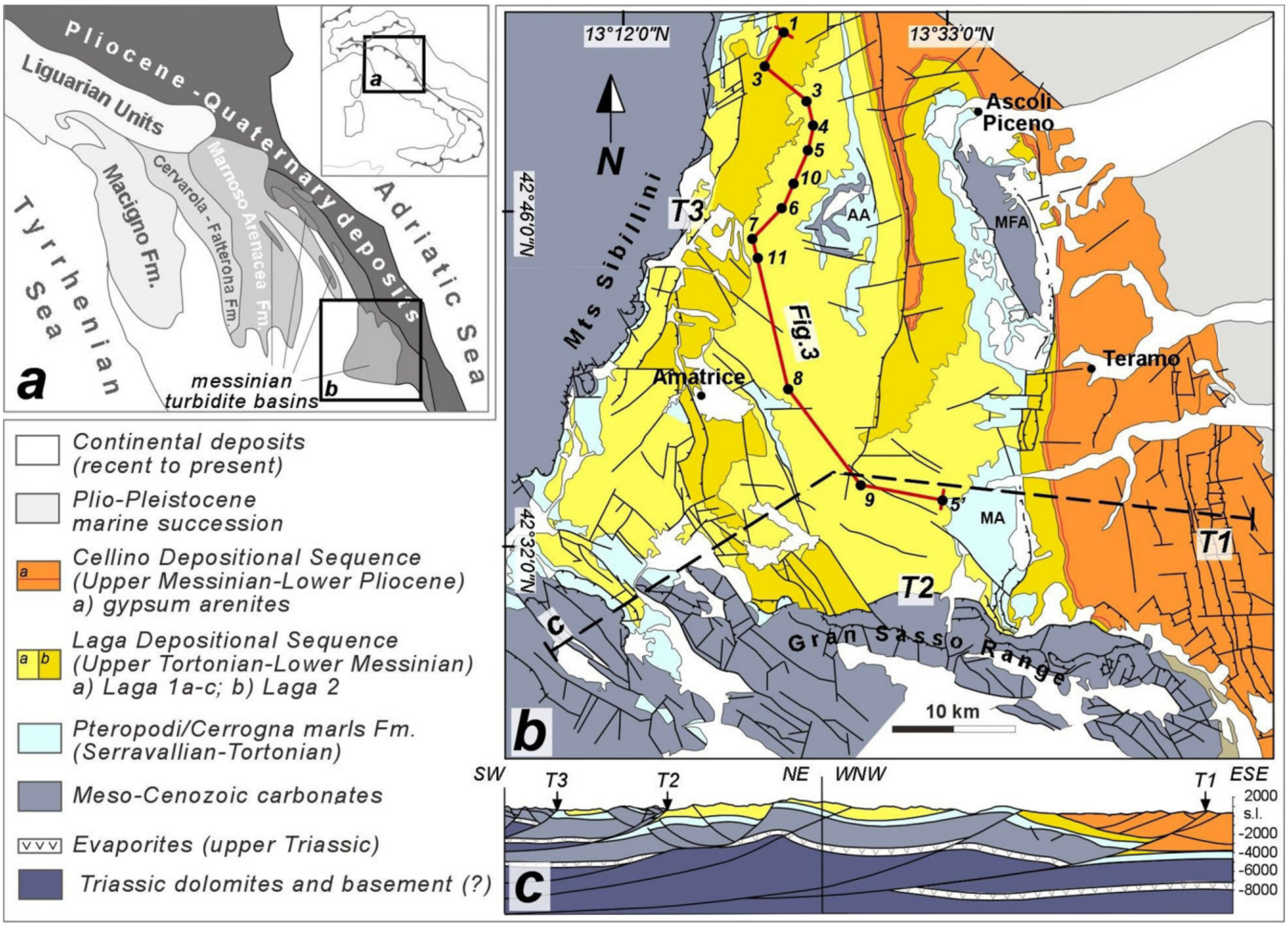
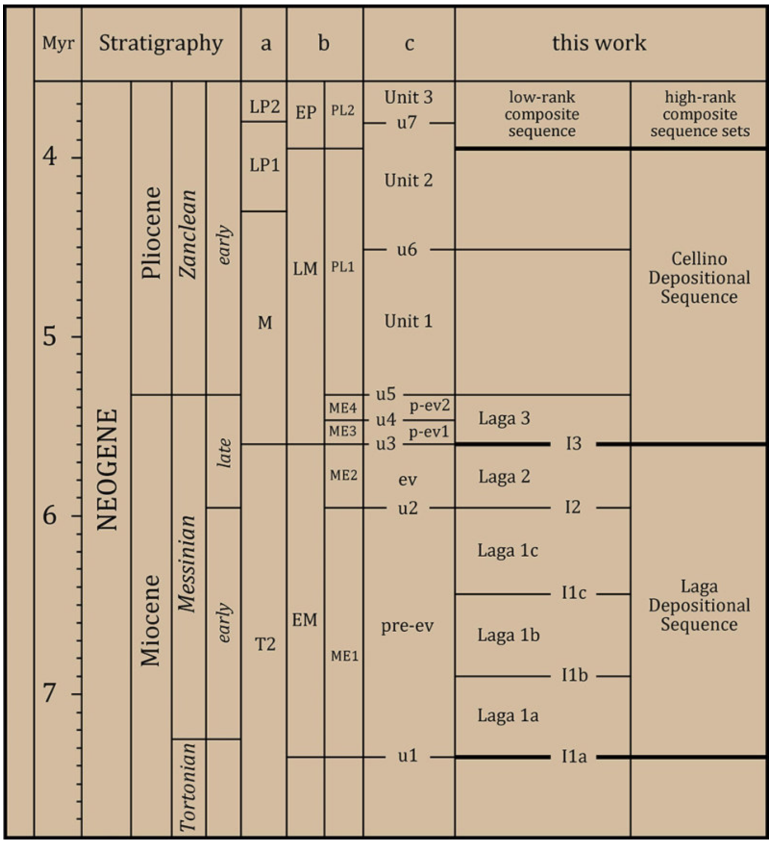



Fig. 1 - Simplified sketches showing: (a) Location of the main turbidite units of Northern Apennines; (b) geological map of the Southern Laga Basin with location of correlation panel of figure 3; (c) geological cross section based on interpretation of seismic line from Bigi et al. (2009). T1: Teramo Thrust; T2: Gran Sasso Thrust; T3: Mts. Sibillini Thrust; AA: Acquasanta Anticline; MFA: Montagna dei Fiori Anticline; MA: Montagnone Anticline.




seismic lines (Bigi *et al*., 2009) suggest that only the Laga 2 unit is present with a lateral continuity in the subsurface of least 10 km (Fig. 1c). The I3 unconformity and the Laga 3 unit records an eastward shift of turbidite depocentre; the I3 represent, in fact, an important chronostratigraphic surface that has been correlated (Milli *et al*., 2007) to the intra-Messinian regional tectonic event (Vai, 1988) and the corresponding Messinian Erosional Surface (MES; see Krijgsman *et al*., 1999; Rouchy and Caruso, 2006). It therefore represents part of the high rank Cellino Depositional Sequence (CDS; Late MessinianeEarly Pliocene) which has been interpreted as the early infill of the Late Messinian-to-Present foreland basin system (Milli *et al*., 2007; 2013; Bigi *et al*., 2009).

*Fig. 2 - Stratigraphic scheme showing the main units recognized in the Messinian Laga Basin with reference to subdivisions proposed by other Authors (a: Ricci Lucchi, 1986 and Ori et al., 1991; b: Ghielmi et al., 2010; 2013; c: Artoni, 2013; d: Milli et al., 2007, 2013). Pre-ev = pre-evaporitic unit; res-ev = resedimented evaporites; p-ev1 and p-ev2 = post-evaporitic units; res-ev = gypsum arenites; v.l. = volcaniclastic layer dated to 5.5 My (Bigazzi et al., 2000); U1-7 and I1a, I1b, I1c, I2, I3 are unconformity surfaces.*

## THE LAGA DEPOSITIONAL SEQUENCE

The present outcrop of the Laga Depositional Sequence is delimited by the Mts. Sibillini to the west and the Gran Sasso Thrust to the south, whereas to the east it plunges in the subsurface below the younger deposits of the Cellino Depositional Sequence (Figs 1b, 1c).

Structural (Bigi *et al*., 2009; 2011) and stratigraphic data (Milli *et al*., 2007; 2011; 2013; Marini *et al*., 2011; 2015) indicate that the Mts. Sibillini and the Gran Sasso thrusts were active since the onset of LDS deposition (Figs 1c, 4a), whereas the outer Teramo Thrust (Figs 1c, 4a) was activated in the early Late Messinian.

In the early stage of turbidite deposition (Laga 1a,b units), the Southern Laga Basin consisted of an elongated, structurally confined trough up to 50 km-long and 20 km wide (Fig. 4) enclosed by the proximal foreland ramp to the east and a western and a distal-southern slopes, located at

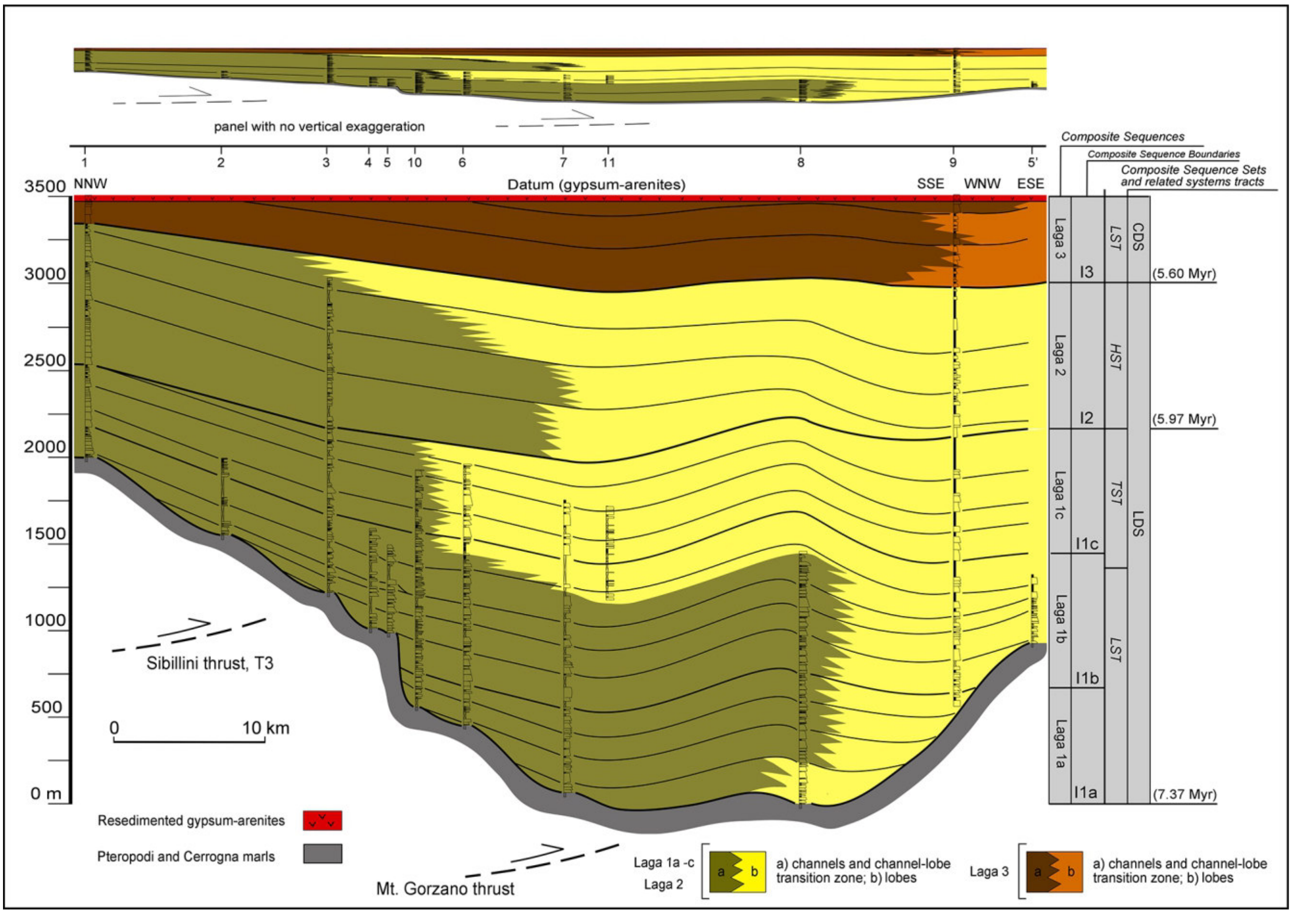



*Fig. 3 - Dip-section correlation panel of the Southern Laga Basin (see figure 1 for location). On the right-hand side stratigraphic subdivisions are reported including composite depositional sequences and related boundaries and composite sequence sets and related systems tracts. LDS: Laga Depositional Sequence; CDS: Cellino Depositional Sequence.*

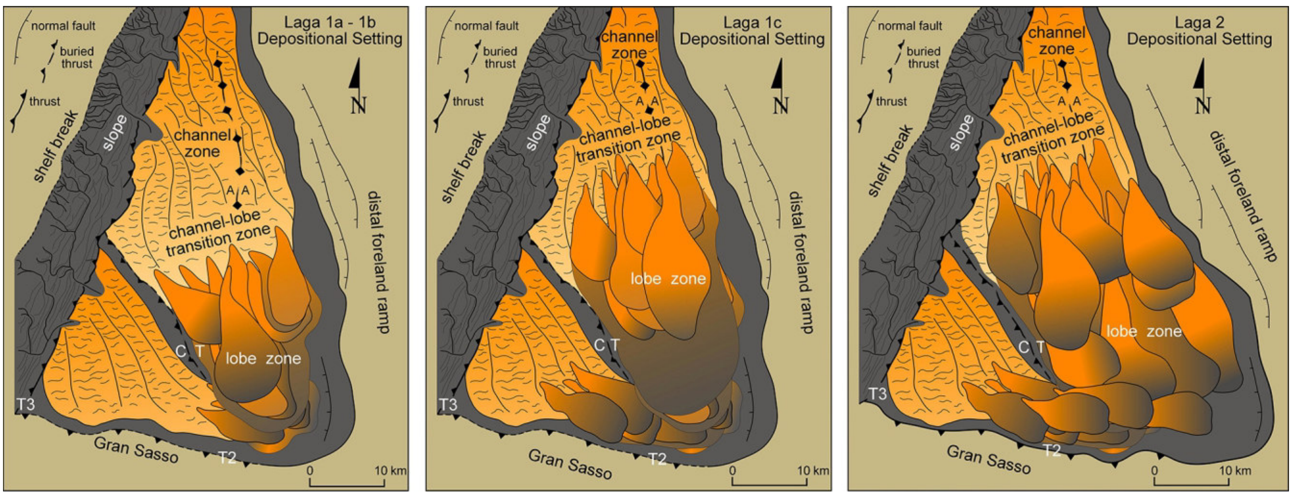



*Fig. 4 - Depositional setting of the Laga Basin duirng the sedimentation of Laga 1a-1b, Laga 1c and Laga 2 units. Note the widening of lobe depocentre. No scale implied for channel and lobe sizes. T2: Gran Sasso Thrust; T3: Sibillini Thrust; CT: Campotosto Thrust; AA: Acquasanta Anticline.*

the footwall of the Mts. Sibillini and the Gran Sasso thrusts, respectively. From the late Early Messinian onwards, high rates of turbidite deposition outpaced tectonic deformation and resulted in rapid infilling and widening of the basin (Laga 1c; Fig. 4). During this mature basin stage, the depocentre consisted of a funnel-shaped depocentre up to 70 km long and 35 km wide in its distal reaches. As suggested by the change in palaeocurrent patterns from the Laga 1a-c to the Laga 2 units (Milli *et al.*, 2007), in the early Late Messinian the ongoing deformation along the Mts. Sibillini Thrust and growth of the Acquasanta Anticline resulted in transient constriction of the northern channelized sector (Fig. 4) and a change in the orientation of depositional lobes (Milli *et al.*, 2007; Marini *et al.*, 2011; 2015). The latest phase of modification of the Southern Laga Basin took place in the Early Pliocene with growth of the Montagna dei Fiori-Montagnone Anticline (Bigi *et al.*, 2011) and relocation of the main turbidite depocentre of the CDS to the east of it.

Based on the presence and partitioning/distribution of architectural elements of turbidite systems, three main depositional zones (Milli *et al.*, 2007; 2013) are identified within the Laga Depositional Sequence, consisting, from north to south and from west to east of:

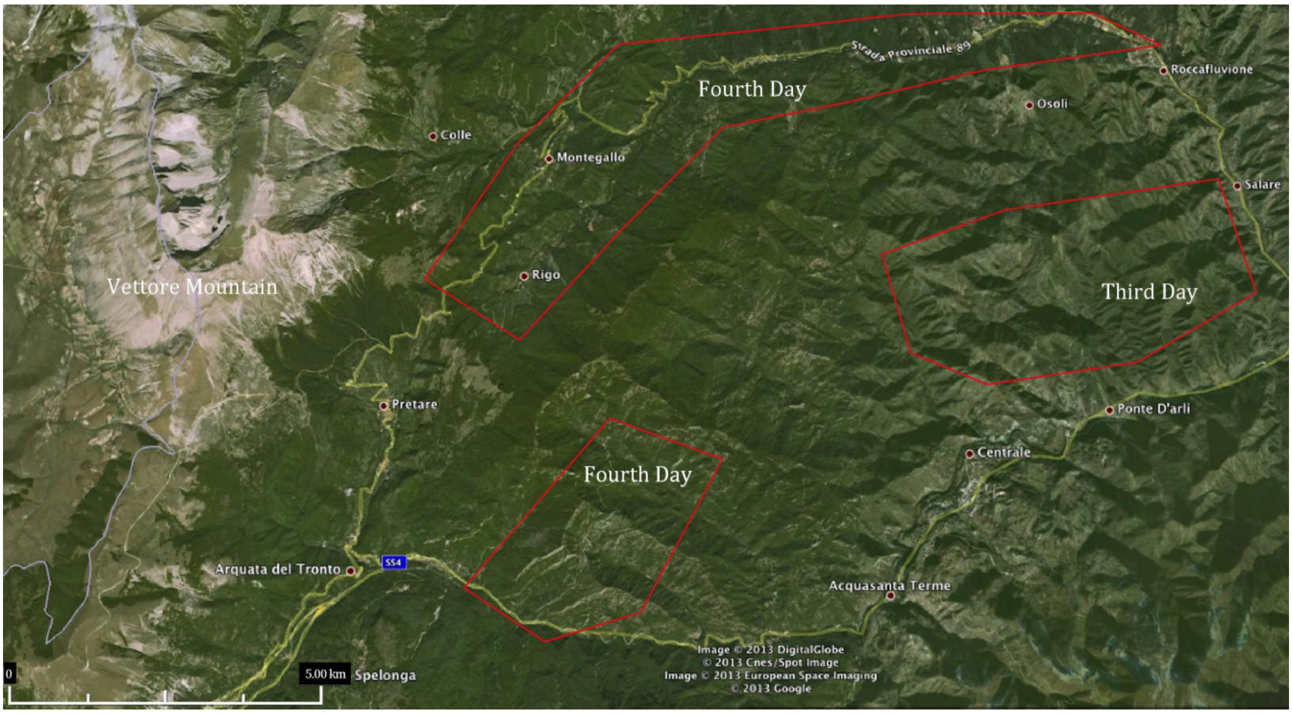
i) a channel complex zone;
ii) an intermediate channel-lobe transition zone;
iii) a distal lobe zone (Figs 3, 4).

The main channel sector consisted of a gently sloping submarine braid plain situated in the northernmost part of the basin and contained between the western slope and the proximal foreland ramp to the east (Figs 3, 4). This represented a distributive network of low-sinuosity to linear braided-like channels provided with coarse-medium sands by canyons cut into the pre-turbidite substrate (Milli *et al.*, 2007). A number of minor channel belts of shorter course were also present in the south-western part of the basin (Fig. 4). Correlations of measured sections with the Campotosto and the Varoni wells (Milli *et al.*, 2007; Bigi *et al.*, 2009) suggest that, at least in the Early Messinian, this sector (the Amatrice sector) constituted a raised south-east sloping sub-basin resting in the hangingwall of the Campotosto Thrust (Fig. 4). The deposits of these channelized sectors consist of amalgamated internally scoured thick-bedded coarse-medium sandstones containing a variety of 3D bedforms (simple to compound dunes, sensu Ashley, 1990, and in some cases, antidunes and chutes and pools structures) as channel-fill.

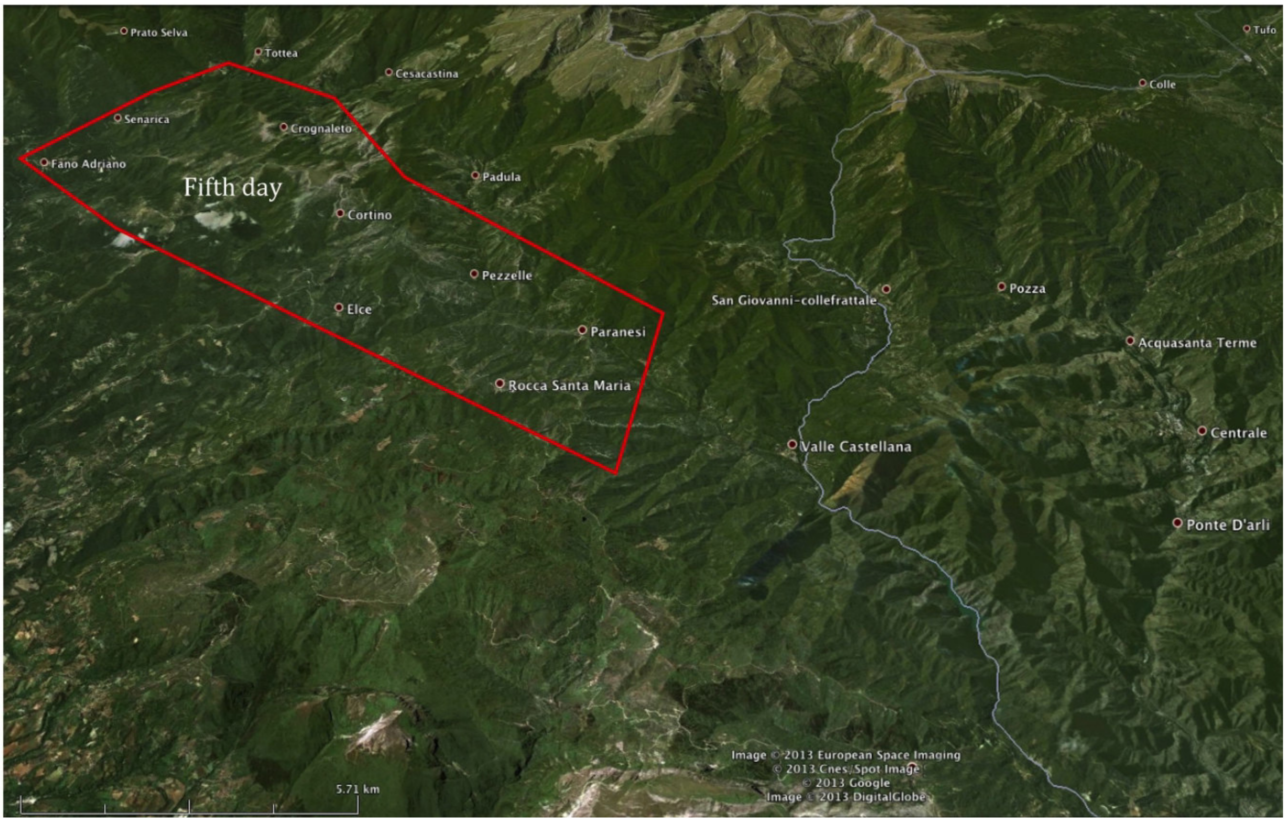
Downstream of channelized sectors, the channel-lobe transition sector (Fig. 4) is characterized by an association of channelized or internally scoured amalgamated sandstones of distal channels and unchannelized deposits of proximal depositional lobes. This interfingering develops at different thickness scales and record forestepping/backstepping of the channel-lobes transition point induced by variations in sediment input. Sedimentary features indicating major sand by-pass generally lack in channel-lobe facies associations, suggesting that lobes were not significantly detached from the feeding channels. The channel-lobe transition represents the along-stream segment of turbidite systems where flows translated into net-depositional as a result of gradual gradient change. Due to the interfingered nature of its deposits the location of the channel to lobe transition zone is somehow subjective. The channel-lobe transition sector represents a non-stationary belt extending over variable lengths (in range between 5 and 10 km) from Acquasanta (to the north) and the Mt. Gorzano-Lake of Campotosto sector (to the west) and the Mt. Bilanciere sector.

Lastly, the lobe sector occupied the southernmost reach of the basin and was laterally and frontally confined by the proximal foreland ramp and the slopes in the footwall of the Gran Sasso and the Campotosto thrusts. However, the size of lobe depocentre might have increased over time (Marini *et al.*, 2011, Milli *et al.*, 2013) as a result of rapid infilling from turbidites and climbing of onlaps onto the confining slopes (Fig. 3).

## Field itinerary




*Location map showing the areas of the outcrops to visit in the Laga Basin during the third and the fourth day*




*Location map showing the area of the outcrops to visit in the Laga Basin during the fifth day.*

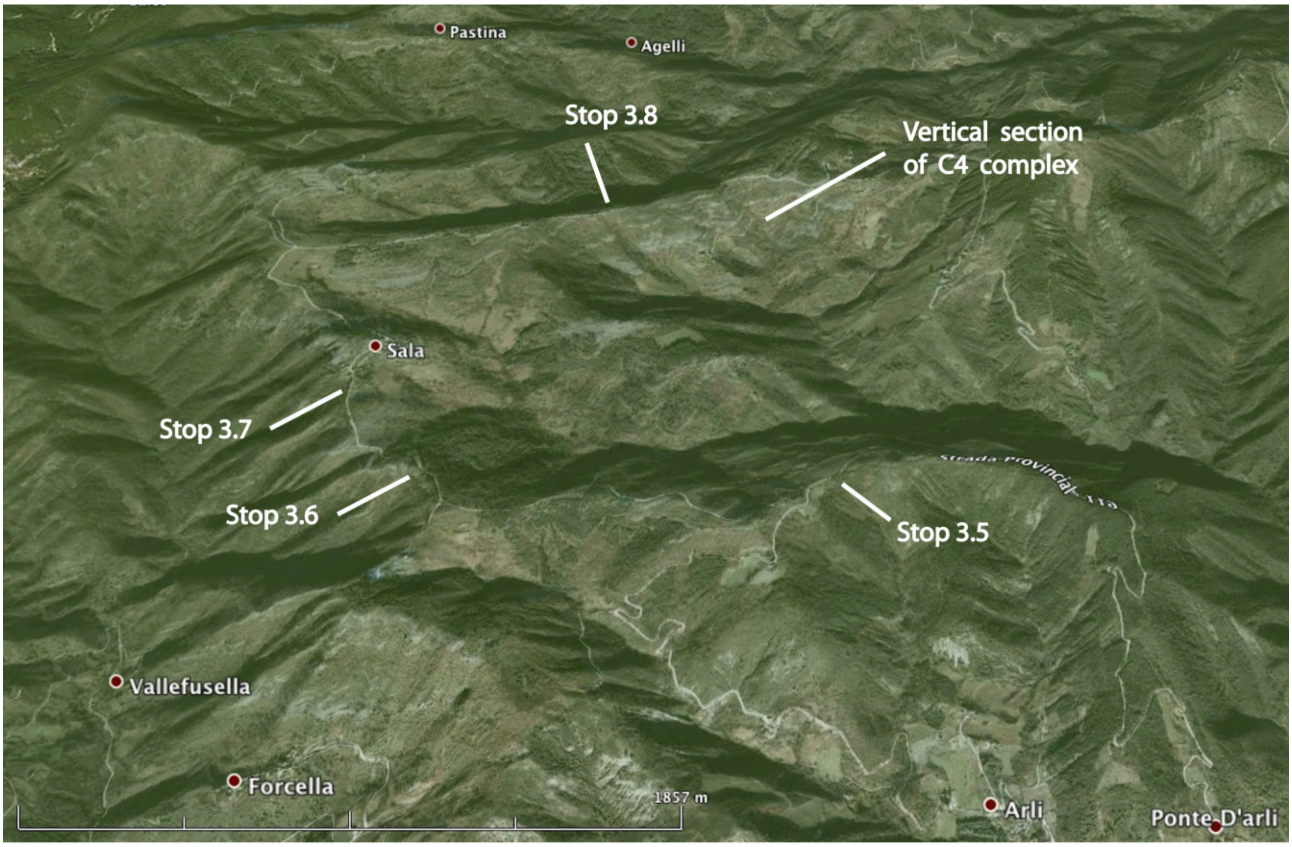
## DAY 3

**After the arrive to the hotel at the lunch time and a brief rest, participants will be introduced to the geology of the central Italy, and in particular to the depositional, paleogeographic, stratigraphic and structural setting of the Laga Basin. Then will have a panoramic view of the Laga 1b channel complexes; facies and sandbody geometries will be observed at outcrop scale.**

## Stop 3.6 Sala 2

Detail on facies and geometry of channel filling (Laga 1b unit) (Fig. 6).

Features to observe: 1) The large scale geometry of channels; 2) The flat to very flat trough cross-bedding occurring in the channel axis deposits, formed through the migration of small and medium scale 3D unidirectional bedforms. Antidunes and chute and pools structures are locally occur.




*Location map of the outcrops to visit during the third day in the Laga Basin.*

## Stop 3.5 Sala 1

Panoramic view of the Laga 1b channel complex.

Features to observe: The onlap of the Laga 1b turbidite deposits onto the submarine structural high related to the incipient Acquasanta anticline (Fig. 5). To note the general stacking pattern and hierarchy of the channelized sandstone bodies.

## Stop 3.7 Scalelle 1

Detail on facies and geometry of channel filling (Laga 1b unit)

Features to observe: 1) the geometry of channels; 2) the small and medium scale 3D bedforms migrating under the passage of turbidity currents.

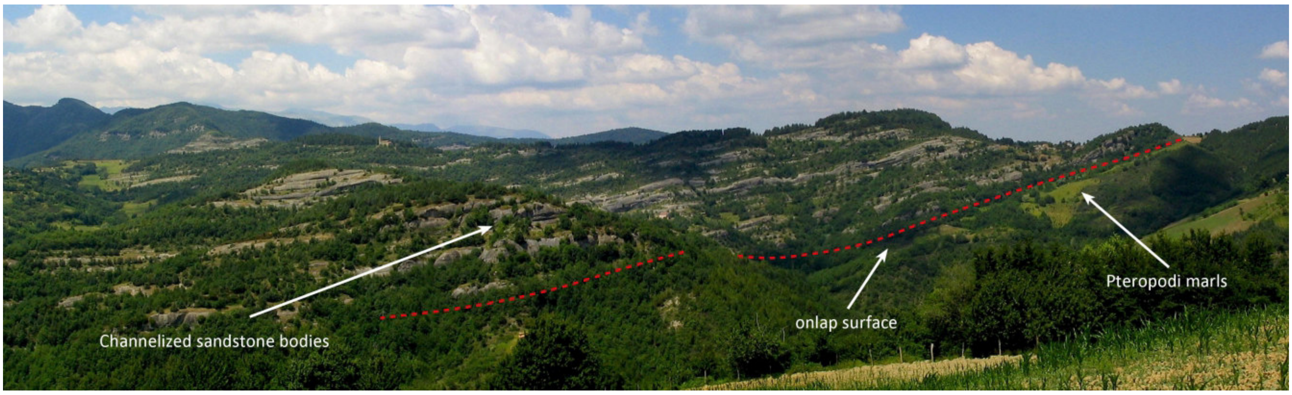



*Fig. 5 - Panoramic view of Laga 1b channel complexes: picture shows the onlap of the Laga 1b unit onto the Acquasanta anticline. Red dotted line indicates the onlap surface and the sequence boundary of LDS . Paleocurrents are from left to right (towards SE).*

*Fig. 6 - Large-scale geometry of a channelized sandstone body (C3 channel complex).*

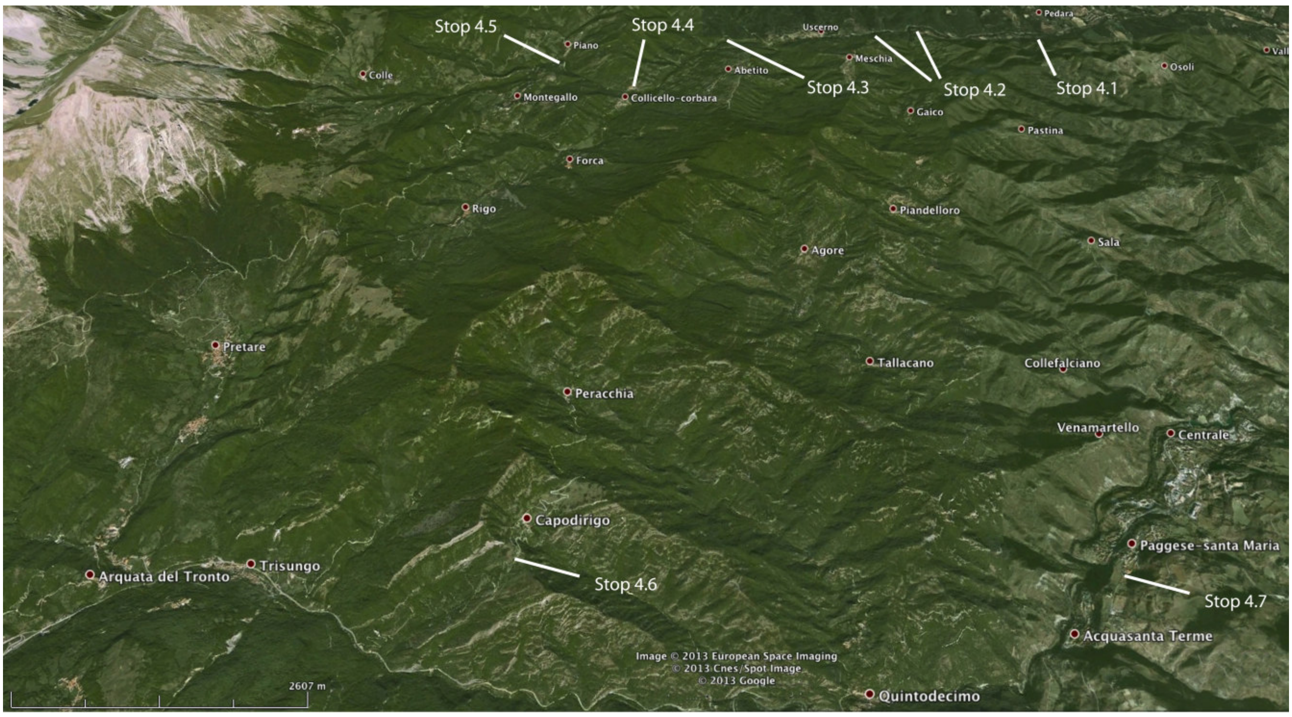
## Stop 3.8 Scalelle 2

Planform geometry and section view of 3D bedforms filling turbidite channels.

Features to observe: 1) the small and medium scale 3D bedforms, often deformed by dewatering processes, constituting the building block of large scale composite dune; 2) the grain-size variation through the beds.

## DAY 4

**During this day we will focused on the channelized facies and geometries of Laga 1b, Laga 1c and Laga 2 units. In the afternoon a panoramic view of lobe and channel-lobe transition deposits related to Laga 1c will be observed.**




*Location map of the outcrops to visit during the fourth day in the Laga Basin.*

## Stop 4.1 Road 89 Val Fluvione (km 2)

Details of channel facies in the Laga 1b unit.
Features to observe: 1) scour features and scour filling; 2) small and medium scale bedforms developed inside the channels; 3) lateral offset stack of channels.

## Stop 4.2 Road 89 Val Fluvione (km 6)

Vertical channel stack and facies of channel margin in the Laga 1b unit.
Features to observe: 1) the erosional base of the channels with large rip-up mudstone clasts and the sedimentological characters of the channel deposits ; 2) facies and geometry of channel margin deposits.

## Stop 4.3 Road 89 Val Fluvione (km 9)

The channelized deposits of Laga 2 unit. Bedforms view in strike and dip sections,
Features to observe: 3D view of low-angle clinostratified composite sandstone dunes constituting the channel filling (Figs. 7 and 8).

## Stop 4.4 Road 89 Val Fluvione (Bisignano village)

The Laga 2 deposits in the proximal sectors.
Features to observe: 1) Details of coarse-grained sandstones forming composite bedforms with lenticular geometries constituting the filling of channels (Fig. 9).

*Fig. 7 - Dip section of a composite dune. Flow from right ro left. The hammer for scale (28 cm).*


*Fig. 8 - The same outcrop of the figure 7 showing the composite dune in strike section.*

*Fig. 9 - Coarse-grained sandstones forming composite bedforms constituting a channel filling. The main erosional surfaces, marked with thick black lines, represent the bounding of the composite bedforms in strike section. The hammer in the circle for scale.*

## Stop 4.5 Road 89 Val Fluvione (Piano village)

The Laga 2 channel deposits in the distal sectors and the passage to the channel-lobe transition zone.

Features to observe: 1) the thick sandstone units with climbing ripples cross-lamination interpreted as overbank deposits, reflecting the traction-plus-fallout of the turbidity currents (Fig. 10); 2) the overlying thick sandstone beds interpreted as proximal lobe deposits.

## Stop 4.6 Capo di Rigo (Tronto Valley)

The Laga 1c deposits in the northern sectors: panoramic view of the channel-lobe transition and lobe zones.

Features to observe: 1) tabular geometry of the sandstone lobes (Fig. 11); 2) cyclicity and stratigraphic organization; 3) small channels or erosional scours at the top of the sandstone lobes?

*Fig. 10 - Fine to very fine sandstone bed with well developed climbing-ripple cross-lamination interpreted as an overbank deposits.*


*Fig. 11 - Medium to thick-bedded sandstone lobes occurring at the channel-lobe transition zone.*


*Fig. 12 - Oblique onlap of the Laga 1b channelized deposits onto the western limb of the Acquasanta Anticline. The thicker white line is the I1a unconformity. The dotted line marks some outcrops of the Marne con Cerrogna Formation. The thinner white lines separate the channel complexes.*

## Stop 4.7 Paggese (Tronto Valley)

Panoramic view of the Laga 1b channelized deposits onlapping onto the western limb of the Acquasanta Anticline).

Features to observe: 1) the unconformity surface at the base of the Laga 1b unit (Fig. 12); 2) the southwestern increasing thickness of the channelized turbidite deposits (towards the basin depocentre).

## DAY 5

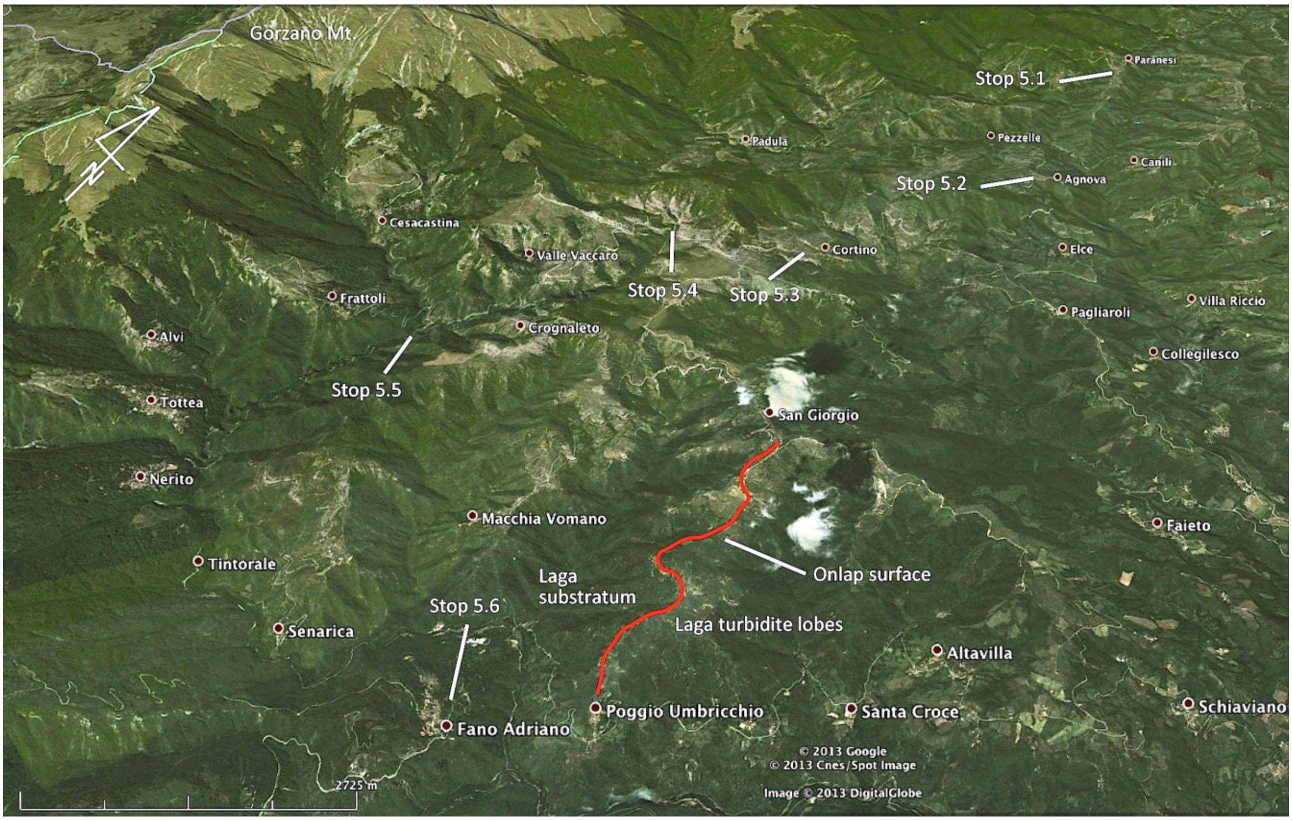
**Third day: check out and move towards the southern sector of the Laga Basin. In the morning, participants will see a detail and a panoramic view of the Laga 1b unit channel deposits in the basinward sector. After a trip of about an hour, during which we will cross the deposits of Laga 1 and Laga 2 units, we will arrive to see the basal portion of the Laga 3 units and in particular the gypsum-arenite turbidites that constitute a continuous marker utilized to correlate the northern with the southern sector of the basin. Later we will move basinward and will see a detail and a panoramic view of Laga 1c and Laga 2 lobes. A panoramic view of the Mt. Bilanciere sector will show i) a strike section of the lobe geometries and ii) the transitional passage from Laga 1c unit to Laga 2 unit. We will see also in detail the physical expression of the maximum flooding surface of LDS into the deeper portion of the basin. In the afternoon the spectacular onlap of the Laga 1b lobe deposits onto the internal slope of foreland ramp will be observed. We will come back to Rome in the late afternoon (3 hours trip).**

## Stop 5.1 Paranesi village

The resedimented gypsum-arenites of the Laga 3 unit.

Features to observe: 1) the transitional passage between the Laga 2 and Laga 3 deposits; 2) composition and sedimentary structures of the gypsum-arenites.

Gypsum-arenites constitute relatively deep-water




*Location map of the outcrops to visit during the fifth day in the Laga Basin. The red line indicates the intersection between the onlap surface of the lobe deposits and the Mesozoic substrate of the Laga Basin* resedimented deposits derived by erosion of primary shallow-water evaporites, formed in semi-enclosed thrust-top basins in the western sectors of the Miocene Apennine foreland basin (for a detailed description see Manzi *et al*., 2005). These deposits are constituted by medium to very fine-grained arenites with gypsum cement. Gypsum crystals are curved (up to 5 mm of diameter) and include remains of anhydrite crystals. The gypsum cement reach about 50-60 % of the sandstones; it derives by the diagenetic transformation of an original clastic gypsum deposited through resedimentation processes. The original texture has been completely obliterated by the successive gypsum-anhydrite-gypsum diagenetic transformations, which are related to the sulphate burial-exhumation cycle. The secondary gypsum formed by hydration of diagenetic anhydrite rocks derived from the burial-induced dehydration of clastic gypsum.

### Stop 5.2 Agnova village

The basin plain sandstone lobes of the Laga 2 allounit.

Features to observe: 1) facies and architecture of the fine-grained sandstone lobes; 2) the high thickness of the sandstone lobes as an expression of basin confinement (Fig. 13); 3) the hierarchy of lobe depositional bodies (event beds; single lobes; lobe sets; lobe complex (Marini *et al*., 2015).

### Stop 5.3 Casagreca locality: a panoramic view of the Mt. Bilanciere

The basin plain sandstone lobes of the Laga 2 allounit.

Features to observe: 1) change of the depositional trend at the passage from Laga 1c to Laga 2 units; 2) cyclicity of the turbidite succession; 3) tabular geometry of the sandstone lobes (Fig. 14).

### Stop 5.4 Altovia locality

The basin plain mudstone and siltstone deposits of the Laga 1c unit.

Features to observe: 1) change in depositional trend at the Laga 1c to Laga 2 passage: the physical expression of the I2 unconformity surface; 2) facies and geometries of thin-

*Fig. 13 - Sandstone lobes of Laga 2 unit. Note the hierarchy of the lobe depositional bodies, and the tabular geometry of the thick sandstone bodies, which is interpreted as the product of a rapid vertical aggradation of the flows related to the basin confinement.*


*Fig. 14 - Panoramic view of the Mt. Bilanciere. Note the tabular geometry of the sandstone lobes of the Laga 2 unit and the downwards transitional passage to the mudstone and siltstone deposits of the Laga 1c unit. Red dotted line approximates the I2 unconformity.*

*Fig. 15 - Calcareous bed intercalated in the basin plain mudstones of the Laga 1c unit. This bed records an underfed phase of the basin and is correlated with the maximum flooding surface of the Laga Depositional Sequence (LDS).*

bedded turbidites; 3) debrite beds; 4) calcareous mudstone beds interpreted as the expression of the maximum flooding surface into the basin of the Laga Depositional Sequence (Fig. 15).

## Stop 5.5 Aprati locality

Thick to very thick-bedded sandstone lobes of the Laga 1a unit.

Features to observe: 1) the great thickness of the sandstone bodies as a consequence of a rapid sedimentation (aggradation) induced by the Gran Sasso frontal slope; 2) the sharp passage between sandstone and mudstone intervals; 3) the presence of thick mudstone units considered as deposited by ponding effect.

## Stop 5.6 Main road 80: Fano Adriano village

Panoramic view of the Laga 1b unit onlapping onto the western limb of the Montagna dei Fiori-Montagnone Anticline (Fig. 16).

Features to observe: 1) geometry and gradient of the Lower Messinian inner foreland ramp; 2) stratal terminations; 3) stacking pattern and cyclicity of the sandstone lobes.


*Fig. 16 - Onlap of the Laga 1b unit onto the Lower Messinian inner foreland ramp. Red line indicates the unconformity surface (sequence boundary of LDS). Gradient of the ramp is estimated about 6°- 8° (see also Casnedi et al., 2006).*

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## Program Summary

The field trip starting from Rome crosses all of central Italy along the A1 motorway. About 5 hours will be needed to reach the first outcrop in the Santerno Valley.

**Day 1 - Saturday 14 September 2019**

After a brief introduction to the geological setting of northern Apennines and Marnoso-arenacea Formation (MAF, Langhian-Tortonian), the field trip will focus on the lower and middle part of the stratigraphic succession, composed of Langhian and Serravallian basin plain turbidites.

*Dinner and night at Imola: Hotel Donatello, Via Rossini 25, 40026, Imola (BO). Tel.: +390542680800; Fax: +390542680514; e-mail: info@imolahotel.it*

**Day 2 - Sunday 15 September 2019**

It will be devoted to the analysis of the Tortonian upper part of the stratigraphic succession in Santerno and Savio valleys. In the late afternoon the structurally-controlled Langhian and Serravallian turbidites, in Savio Valley, will be observed.

*Dinner and night at Bagno di Romagna: Tosco Romagnolo Hotel, Via del Popolo 2, 47021 Bagno di Romagna (FC); Tel. +390543911260; e-mail: info@hoteltoscoromagnolo.it*

**Day 3 - Monday 16 September 2019**

The early morning will be devoted to the analysis of the Serravallian middle part of the stratigraphic succession in Savio valley where magnificently exposed tectonically-confined basin plain turbidites can be observed (10. 00 - Drive to the Laga Formation).

Arrive to the hotel at the lunch time. After a brief rest, participants will be introduced to the geology of the central Italy, and in particular to the depositional, paleogeographic, stratigraphic and structural setting of the Laga basin. Then we will move for the first stop. Participants will have a panoramic view of the Laga 1 channel complexes; Facies and sandbody geometries will be observed at outcrop scale.

*Dinner and night at Ascoli Piceno: Hotel "Villa Pigna" Via Assisi 33, Villa Pigna di Folignano, 63084 Ascoli Piceno. Tel.: +390736491868; Fax: +390736390653; e-mail: info@hotelvillapigna.it*

**Day 4 - Tuesday 17 September 2019**

it will be devoted to the analysis of the proximal portion of the Laga basin (the northern area). We will analyze the filling of the Laga 1 and Laga 2 channel complexes. A spectacular panoramic view of the Laga 1 channe-lobe transition zone as well as of the sandbody geometries will be observed.

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**Day 5 - Wednesday 18 September 2019**

it will be devoted to the analysis of the Laga 1 and Laga 2 lobe deposits: depositional architecture of the lobes, their geometries and facies will be discussed. Participants will also observe the onlap geometries of the Laga 1 and Laga 2 deposits onto the foreland ramp and the deforming anticlines. In the afternoon, return to Rome.

## Safety

Safety in the field is closely related to awareness of potential difficulties, fitness and use of appropriate equipment. Safety is a personal responsibility and all participants should be aware of the following issues.

The excursion takes place at relatively low altitude (less than 1000 meters). Most of the outcrops are along theroad and we will not make long walks. Roads are goods although to reach outcrops will be necessary to drive along very sinuous roads. All participants require comfortable walking boots. Trainers or running shoes are unsuitable footwear in the field. A waterproof coat/jacket is essential. In September the weather is relatively stable although changes with rain are possible. Waterproof over-trousers may be useful. A small rucksack is needed for daily use. This needs to be at least big enough to carry your waterproofs, a spare T-shirt (and maybe a fleece/sweater), a bottle of water and small snacks. Sun protection can be useful; hats or headscarves are useful. Participants should inform the excursion leaders (in confidence) of any physical or mental condition, which may affect performance in the field (e.g. asthma, diabetes, epilepsy, vertigo, heart condition, back problem, ear disorder, lung disease, allergies etc.). Special diets are available on request (vegetarian, etc.). Each vehicle will carry one basic first aid kit. Mobile/cellular phone coverage is good although in same place it can be absent.

The emergency telephone number for ambulance is **118.**

The emergency telephone numbers for police is **112** and **113**

# FIELD LEADERS

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