

# THE GEOSITE OF THE MOUNT SERRONE FAULT



Hello! I am "Gioia" and...  
....this is my fault scarp



## GEOLOGICAL-TOURIST MAP

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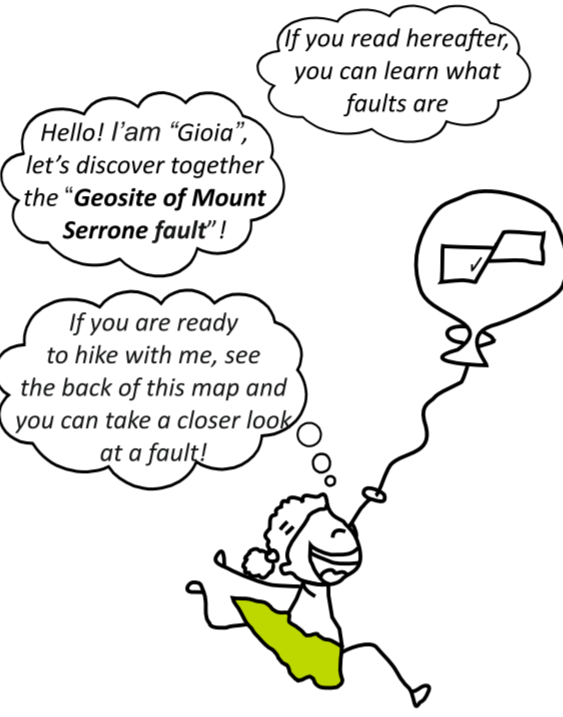
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## The Geosite of the Mount Serrone Fault

Geosites are elements, zones or sites with geological interest and relevant naturalistic value. In 2016 the "Geosite of the Mount Serrone Fault" was included in the "National Inventory of Geosites" (ISPRA, Ministry of Environment). The geosite is located in the mountain area of the Abruzzo Apennines in Central Italy (Marsica region), in the eastern sector of the Fucino Plain (Gioia dei Marsi, AQ). Here, it is possible to observe a fault, a well-known geological element, strictly related to seismicity and earthquakes that have affected the Central Apennines. It is also possible to recognize the evidence of the ancient history of the Apennines rocks, lasting for millions of years, and of its more than 2 million years old landscape. This history began at least 150 million years ago in this area (more than 250 million years in the Apennines in general). There was an ancient life-rich sea with shallow waters, where limestones rocks were formed. Then, the sea became deeper and clay rocks were formed. Today, we find these rocks on the top of the mountains! The movements of the earth crust (tectonics), caused by far and deep pushes, have deformed the rocks uplifting them out of the sea and forming the Apennines mountains, among which the Serrone ridge, locally known as "Mount Serrone".

Today, we can see a steep mountainside with a rounded summit. However, a wide arcuate grey belt catches our eyes. It is the "Mount Serrone Fault" and tells us an incredible story! It is part of a fault system that bounds the entire Fucino Plain and has had a complex history of movements and deformations for more than 2 million years. These movements have produced many earthquakes including the one occurred on January 13<sup>th</sup>, 1915. However, they are responsible for creating the wonderful landscape that we can see today as well, forming the ridges of the Apennines and the Fucino Plain, once occupied by a big lake. If you read the following texts and look at the geologic tourist map on the back of this sheet, you will have the chance to discover the Geosite of the Mount Serrone Fault and to learn more about faults, earthquakes and the story of the Apennines landscape.



Hello! I am "Gioia", let's discover together the "Geosite of Mount Serrone fault"!

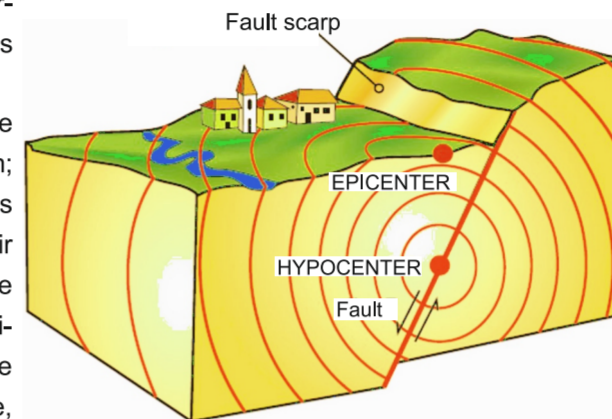
If you are ready to hike with me, see the back of this map and you can take a closer look at a fault!

If you read hereafter, you can learn what faults are

## The earthquakes

The term "earthquake" is referred to as quakes of the Earth surface due to tectonic movements. The earthquakes are due to the massive energy abruptly released by Earth crust deformations. They occur at a depth of several km (usually from less than 10 km to more than 500 km), at a point called hypocenter. Above it, at the surface, there is the epicenter, where the worst shaking and damages usually occur. Earthquakes can be considered as the "hearth pulse" or the "breath of the earth". Due to the crust movements, faults and earthquakes, the Earth changes ... mountains, valleys, plains, seas, and the landscape in general, are formed. That is why faults and earthquakes are fundamental for the life of the Planet Earth (as the heart pulse and breath are for human beings!), even if they may be dangerous for us. Like listening to the heart or breath and studying the human body, allow us to understand our disease and health, studying faults, earthquakes, the Earth and its landscape, will help us to understand the health of the Planet and where earthquakes and other disasters may occur. If we learn to know our body, we understand our health; if we learn to know our Earth, we understand how to protect ourselves from its movements!

Earthquakes always occur. Some are weak and we do not even feel them; others are strong and "scare" us damaging our houses and cities. Their strength is measured in magnitude grades (M, Richter scale), which indicates the released energy. Magnitude 9 or more has been recorded (beware, for 1+ grade, the energy is thirty times greater). The Mercalli scale (MCS) indicates the feeling and the damages due to an earthquake, measured in grades of Intensity, in roman numbers from I (only recorded by seismometers) to XII (total damage, waves seen on ground surface).

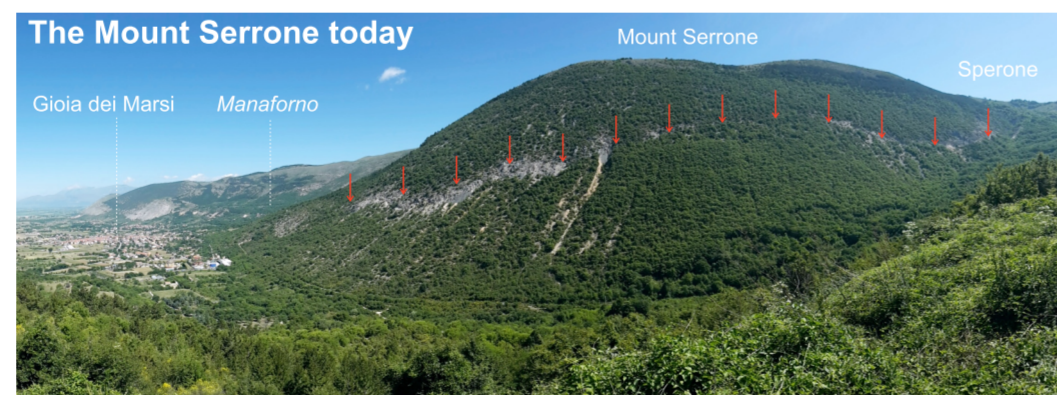


## The Fucino Earthquake of January 13<sup>th</sup>, 1915

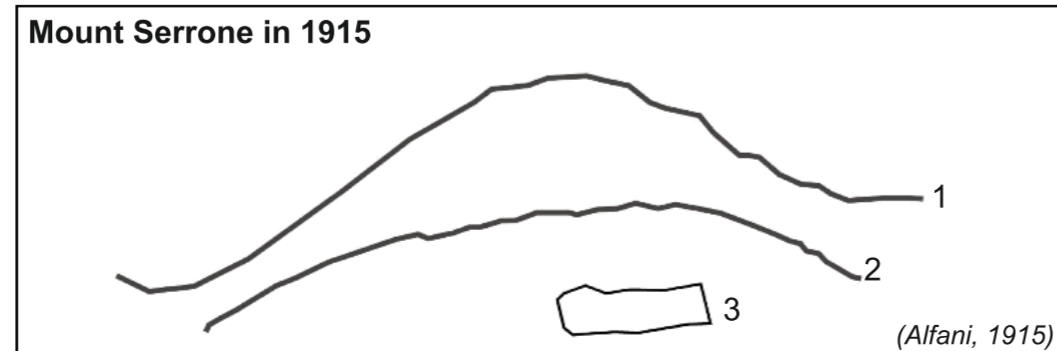
The Mount Serrone Fault Geosite is located in one of the most seismic areas of Italy, which was affected by the devastating Fucino earthquake on January 13<sup>th</sup>, 1915 (intensity XI, magnitude 7.0). In 1349 another strong earthquake occurred in this zone, and detailed studies on the faults have recognized at least ten more occurred in the last 33.000 years. Moreover, this area suffered remote effects of the 2009-2017 Central Italy seismic crisis; L'Aquila (2009, M 6.3), Amatrice-Accumuli (2016, max M 6.5) and Monteverde (2017, M 5.4) earthquakes.

## What are faults?

A fault, in geology, is a plane (or a planar fracture) affecting a volume of rock of the Earth crust, across which a significant slip and displacement between two rock masses have occurred. Faults are the result of crust movements and deformation (tectonics). The deformation occurs slowly (some millimeters or centimeters per year) and elastically (like a rubber band) for tens, hundreds or thousands of years. When the deformation is too much, the crust rocks crack along a fault, a sudden slip occurs (ofr some centimeters, decimeters or even meters) and an earthquake is triggered. As like as we bend a wooden branch: it bends gradually, but if we bend it too much, it snaps abruptly. Where a fault intersects the ground surface, we can see a fault "trace" into the landscape: a scarp or a plane, along which two different rocks are in contact, like on the Serrone slope.



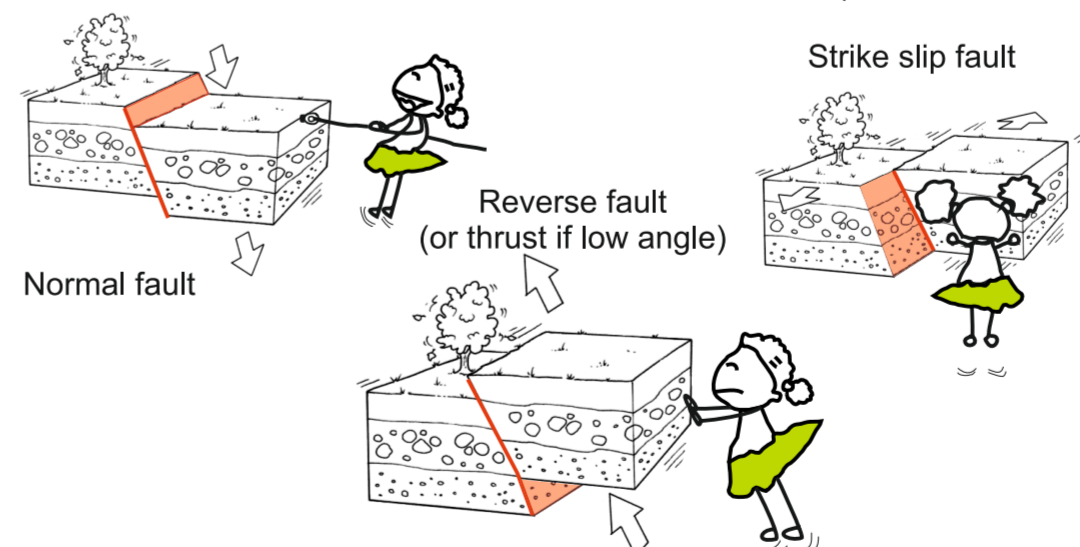
Looking at Mount Serrone, the fault trace that rips the landscape can be observed, with a grey arcuate shape (red arrows). The ancient villages of Sperone and Manaforno are along the fault scarp and the vegetation has covered the remains of Manaforno (see short notes on the history of Gioia dei Marsi).



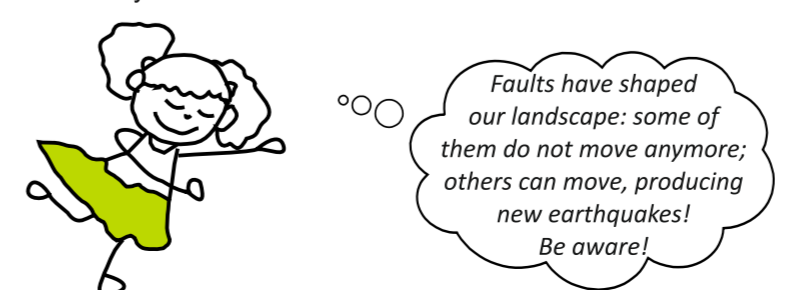
This scheme was drawn by Padre G. Alfani while traveling through the villages badly stricken by the 1915 earthquake. From top to bottom: the Mount Serrone profile (1), the fault scarp in the middle of the slope (2) and the approximate location of Manaforno village at the foot of the slope (3).

## Do good or bad faults exist?

Faults are called "normal", "reverse" and "strike-slip" depending on tectonic movement (look down here at "Gioia" who pulls, pushes or moves transversely the rocks). In normal faults, such as the Serrone one, extensional movements induce a rock-mass to be lowered with respect to another. In reverse faults or thrusts, compressional movements induce the rock-masses to be overlapped one over the other. In the strike-slip faults, rock-masses slide one by another. Furthermore, faults never go alone! They are combined in "faults systems", sets of faults lined up, which might be from just hundreds of meters up to thousands of kilometres big. Actually, good or bad faults do not exist. However, some of them are "active" and may trigger earthquakes, while others are "inactive" and are not connected to earthquakes.



Some faults scare us! They have moved, triggered recent earthquakes and can trigger new ones. These are defined as "active faults" and can be hidden in depth or visible at the surface. The Mount Serrone fault is an active fault visible along the mountain side. Other faults indeed, were not interested by movements or earthquakes in the last dozens or hundreds of thousands years and are defined as "inactive faults". No fear then!



Faults have shaped our landscape: some of them do not move anymore; others can move, producing new earthquakes! Be aware!

## Short notes on the history of Gioia dei Marsi



Gioia dei Marsi, 7,52 on January 13<sup>th</sup>, 1915, the time of the earthquake that not a single stone left standing. The village (5000 inhabitants) originated from the merge of the pre-roman Templo, Kampomizzo, Montagnano villages. The inhabitants of "Manaforno" (ancient name of Gioia dei Marsi), most of which (about 3000) perished due to the earthquake and related damages, were farmers, artisans, peasants and shepherds, dedicated to "transhumance". Its schools were very busy and Salesian Sisters, living in Gioia dei Marsi since 1899, were devoted to girls' education. The Gioia people were dwelling in Old Gioia village, at 1410 m a.s.l. on the route to Pescasseroli. Here, they built a rich church dedicated to San Vincenzo Martire, which was destroyed by the 1915 earthquake and then restored. Since XIX century, the Gioia people, moved down to a new village at 750 m a.s.l., closer to the warmer and fertile plain of the

Fucino Lake (reclaimed in 1876) and Gioia dei Marsi became the main town. After the earthquake, it received solidarity from all over the country for its reconstruction and was adopted by the city of Ferrara. Today, it is important for the Fucino agricultural economy and is the "Marsican" door to the Abruzzo, Lazio and Molise National Park. Here Fonte Vecchia, Fonte di Vico of Casali d'Aschi and the Old Sperone Tower, today Borgo Sperone, are beloved symbols of the village's history.

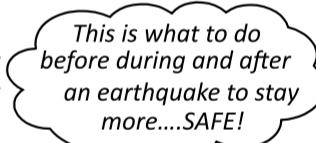
## Further readings

INGV Istituto Nazionale di Geofisica e Vulcanologia ([www.ingv.it](http://www.ingv.it))  
ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale ([www.isprambiente.gov.it](http://www.isprambiente.gov.it))  
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## Good behaviour in seismic areas

(modified from <http://www.protezionecivile.gov.it>)

**With the advice of a technician**  
Sometimes you might just need to reinforce load-bearing walls or improve connections between walls and floors: to make the right choice, seek the advice of a qualified technician.



This is what to do before during and after an earthquake to stay more...SAFE!

**On your own, immediately**  
Move heavy furniture away from beds or sofas. Fix to the wall shelves, bookcases and tall furniture; hang pictures and mirrors with closed hooks, in order to prevent them to come off the wall. Put heavy items on lower shelves; on the higher ones, you can hold objects with double-sided tape. In the kitchen, secure the cupboard flaps for plates and glasses, so that they do not open during shaking. Learn where are and how to turn off the gas and water lines as well as the master switch of the light. Pinpoint safe places in the house, where you can find a shelter in case of an earthquake: doorways, angles of the walls, under the table or under the bed. Prepare an emergency backpack for each person (as indicated by European Commission and FEMA Federal Emergency Management Agency) containing: a drinking water bottle, battery or rechargeable flashlight, a little First Aid Kit and generic medicines, personal hygiene material (soap, towel and disinfectant gel), long-lasting foods (chocolate, honey, cookies), two lighters, a multipurpose tool, a portable radio and spare batteries. You might include also: copy of personal documents, emergency and familiar contacts, little toys for kids, etc. Get informed about the Civil Protection Plan of your Municipality or ask for it, in order to know how to behave in case of emergency. More info at [www.fema.gov/media-library/assets/documents/7877](http://www.fema.gov/media-library/assets/documents/7877).



**During an earthquake**  
Find a shelter under a beam, in the doorway or by a load-bearing wall. Watch out for things that could fall and hit you (plaster, ceilings, windows, furniture, etc.). Pay attention to the stairs: in general, they are not very resistant and can be damaged. Avoid taking the lift: it can get stuck. Move away from buildings, trees, lampposts, power lines: you could be struck by falling materials. Pay attention to other consequences of the earthquake: collapse of bridges, landslides, gas leaks, etc.

**After an earthquake**  
Make sure of the state of health of the people around you and, if necessary, be the first aider. Come out with caution, wearing shoes: you may get hurt in the streets with broken glass. If you are in a zone exposed to tsunamis, move away from the beach and reach a higher place. Limit, as much as possible, the use of the phone. Limit the use of the car to avoid obstructing the passage of emergency vehicles. Reach the waiting areas provided by the Civil Protection Plan of your Municipality.

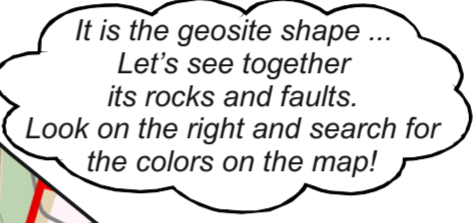
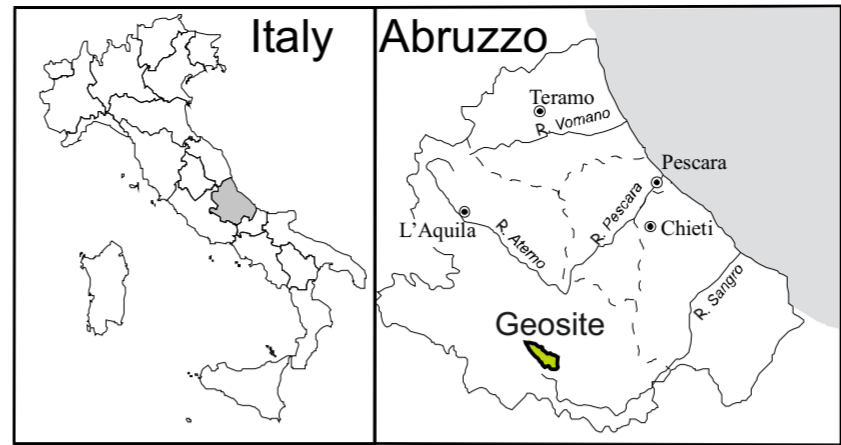
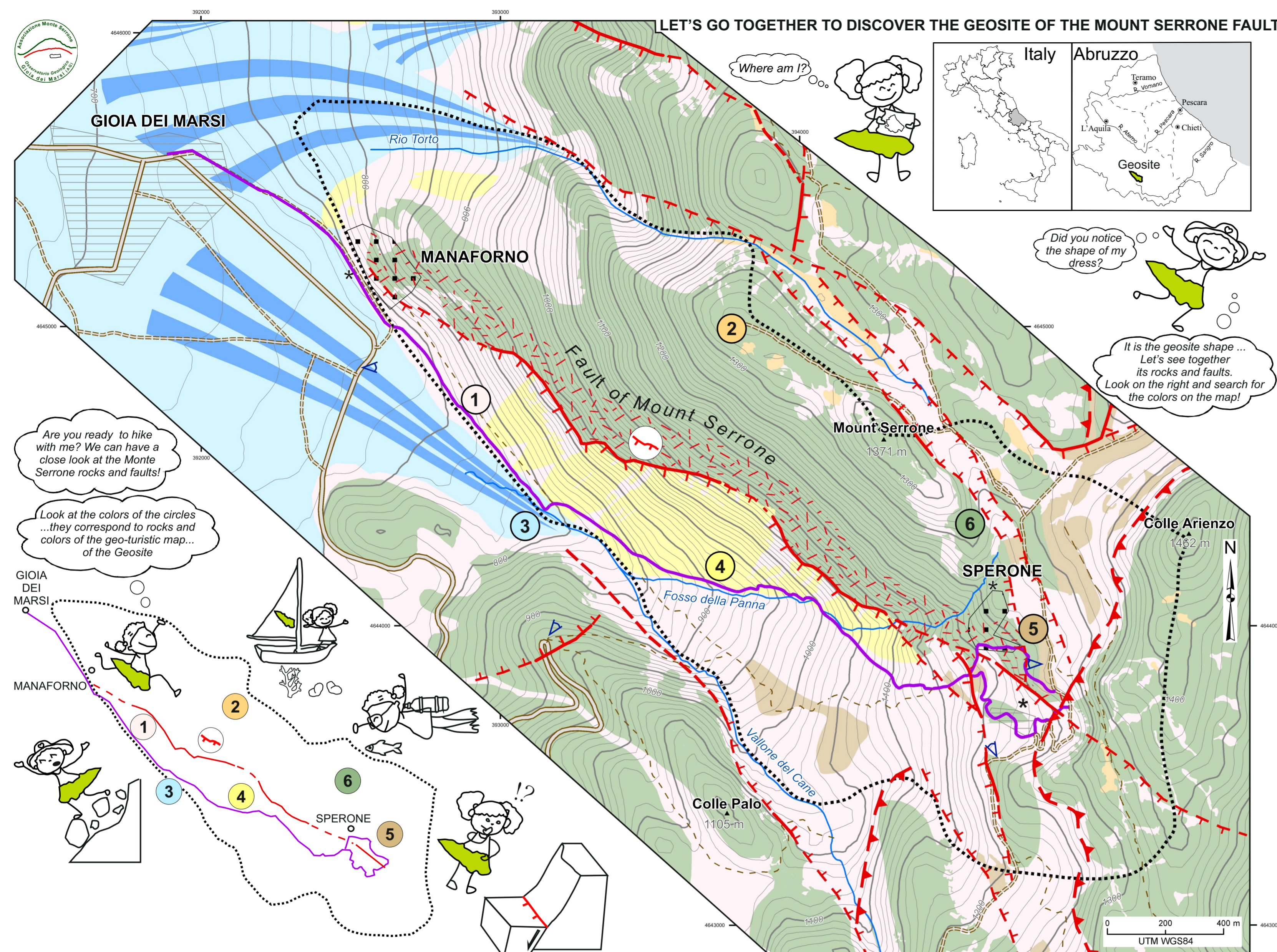


The Monte Serrone fault Geosite was realized for the social, cultural and scientific promotion of the landscape and geological heritage of the Gioia dei Marsi area. In the Geosite, activities focused on popularizing Earth Sciences, and sensibilization to natural hazards prevention for tourists, citizens, and schools were realized, in collaboration with international and Italian Universities, research and education institutions. It is located in Gioia dei Marsi (AQ, Abruzzo, Central Italy), in the SE edge of the Fucino plain and can be easily reached from the A25 Parks' Highway.

## How to reach the geosite

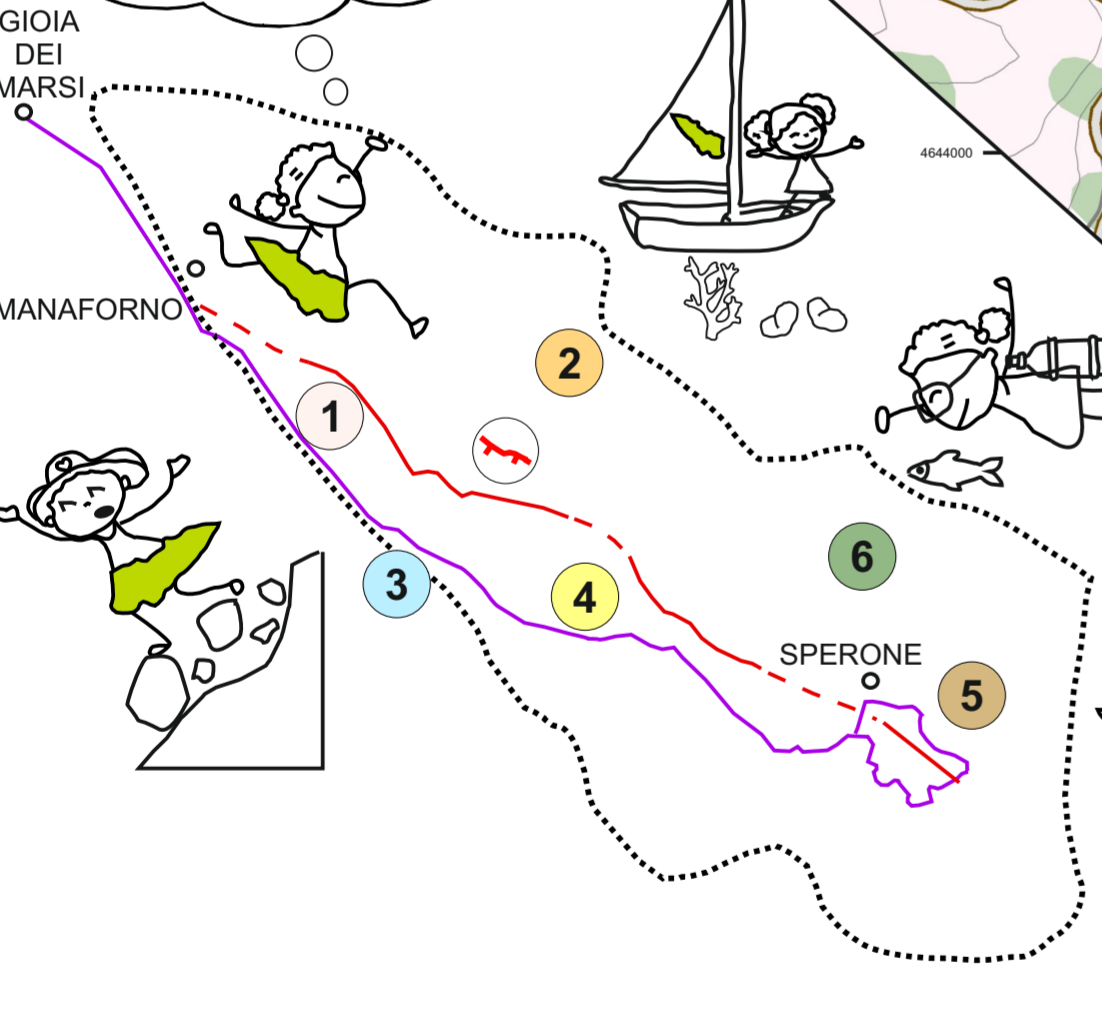
**By Bus:** Bus to Gioia dei Marsi from the Avezzano Bus station.  
**By car:** from the Highway A25 Roma-Pescara, Pescara exit. After the exit, turn left and then follow the signs to Gioia dei Marsi (13 km to destination). With your smartphone or tablet, scanning the QR-code on the left, you will access to Google-Map waypoint in Gioia dei Marsi (AQ).

LET'S GO TOGETHER TO DISCOVER THE GEOSITE OF THE MOUNT SERRONE FAULT



Are you ready to hike with me? We can have a close look at the Monte Serrone rocks and faults!

Look at the colors of the circles ...they correspond to rocks and colors of the geo-turistic map... of the Geosite



**HOW THE ROCKS WERE FORMED? ROLLING ON THE SLOPES**  
**Recent debris** - Fragments of limestone rocks rolled down from the mountainsides and deposited at the base of the slopes in sandy and clayey soils. They have formed in the last thousands years (Holocene) and are still forming.

**WHERE WATERS DISSOLVES THE ROCK**  
**Red soil** - It is a reddish clayey and sandy soil, forming due to rain water dissolving limestones (karst processes) leaving an iron rich residual soil. It is present mostly in the bottom of circular karst depressions (dolines). It has formed in the last 100.000 years (Upper Pleistocene - Holocene).

**TRANSPORTED BY THE WATER**  
**Ancient gravel** - Stratified and poorly cemented gravels transported and sedimented by stream water. They form big fan-shaped cones (alluvial fans). The age is from 100.000 to 10.000 years ago (Upper Pleistocene).

**ROLLING ON THE SLOPES**  
**Ancient debris** - Its origin is the same as the recent debris, but this deposit was compacted and cemented through time. It covers the Mount Serrone foothill along the fault. It was formed from 100.000 to 10.000 years ago (Upper Pleistocene).

**IN AN ANCIENT DEEP SEA**  
**Clay rock** - It is composed of clay layers with some sand and sandstone levels. It was deposited in an ancient deep sea, when the mountains of the Apennines began to form, emerging from the sea, from 10 to 5 million years ago (Miocene).

**IN AN ANCIENT SHALLOW CLEAR SEA**  
**Limestone rock** - It is made up of hard and thick limestone strata. It was deposited in a clear, warm and shallow sea bed, rich in seaweed, shells, and molluscs. Its age is from 145 to 10 million years ago (from Cretaceous to Miocene).

**ALONG THE FAULTS**  
**Fault rock** - It is a white and bright limestone sand and breccia, from hard to loose. It was formed by the deformation and crushing of lime-stone rock due to movement and friction along the faults and during its activity.

**...AND HERE IS A FAULT "MIRROR"**  
 It is a smooth rock scarp, almost glossy that can be observed where faults intersect the surface. It has formed due to the tectonics slip along the faults, occurring mostly during the strong earthquakes (such as the Fucino in 1915).

**GEOLOGIC TIME SCALE**

Find the circles in the geologic time scale, in the itinerary, in the map, and in the legend... you can discover a million years long history... of ancient seas and new mountains

Million years	210	140	66	24	5	2,6	0,01	Today
Period (colors indicate the age in the geologic time scale)	Early, Middle, Late	Lias, Dogger, Malin	Early, Late	Paleocene, Eocene, Oligocene	Miocene, Pliocene	Pleistocene	Holocene	
Epoch	Triassic	Jurassic	Cretaceous	Paleogene	Neogene	Quaternary		
What happens in Abruzzo	Sedimentation and formation of Abruzzo's rocks			Abruzzo's mountains start forming		Faults' movements (such as Mount Serrone fault) and landscape shaping		

The history of the Mount Serrone rocks starts here

Activation of normal faults such as Mount Serrone fault

1915 Fucino earthquake

**Legend**

- Normal fault (well-visible fault mirror)
- Normal fault (not-visible fault mirror)
- Monte Serrone fault Geosite boundary
- Contour lines from topographic database of Regione Abruzzo (2007)
- Mount summit
- Stream
- Main roads
- Secondary Roads
- Other trails
- Trail Gioia dei Marsi - Sperrone
- Urban area
- Ruin area
- Point of interest
- Panoramic view site
- Geological observatory Associazione Monte Serrone
- Thrust or reverse fault (buried under debris or gravel deposits)
- Normal fault (buried under debris or gravel deposits)

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