

Lebanon's geological history spans millions of years and showcases a wide array of captivating phenomena. Jbeil Geotrails constitute an invaluable pathway to explore this geological heritage. This network of Geotrails in Jbeil mountains does not only reveal Lebanon's geological heritage but also its influence on the physical and cultural landscapes. Beyond being hiking trails, the Jbeil Geotrails offer an immersive educational experience for adventurers and nature enthusiasts. They invite hikers to embark on a journey of enjoyment and learning to understand Lebanon's geological diversity. With each step hikers will be transported through epochs of time, tracing the geological processes that formed the Lebanese landscape. Beyond their scientific significance, Jbeil Geotrails celebrate Lebanon's rich heritage, connecting the geological, natural,

and cultural dimensions, and reflecting the symbiotic relationship between humans and their environment.

The Lebanese lithology (rock types) is composed of sedimentary and igneous rocks spanning from Jurassic (180 million years) to most recent Quaternary. Sedimentary rocks are composed mostly of limestone, dolomitic limestone, dolostones, marls and sandstones. Igneous rocks are due to episodes of magmatism (volcanism) in Jurassic and Cretaceous periods and Pliocene epochs. Lebanon consisted of a vast marine depositional environment for sedimentary rocks. In the Miocene times (starting 15 Ma*), Lebanon has been rising gradually from below the sea because of the regional tectonics.

Parallely, for the last 2000 years, sea level has been rising because of global warming and global ice melting.

Lebanon is intersected with various faults (northeast-southwest), and east-west faults, and a major fold (bent structure) oriented in the Northwest-Southeast direction, extending through the entire length of Lebanon and ending with a coastal flexure.

The Geological history of the area can be divided into periods of sedimentary deposition below the sea and periods of uplift above the sea due to regional tectonism, during which weathering/ erosion and no-deposition occurred. Sea level changes play a role in the exposure of the rocks and their erosion (weathering and removal).

Sea level changes are classified either as regional affected by tectonic changes (uplift and subsidence) or because of absolute sea level rise (melting of the ice poles during the interglacial ages).

These trails give you the opportunity to go on a journey through geological times, to explore Geothemes varying from fossils, deposition, geological structures, hydrogeology (water and springs), karst landscapes and caves to volcanism and many more.

These Geothemes will be explained in terms of processes, scales, ages and duration and governing natural and geological parameters.

*Ma: Mega Annum = Million years

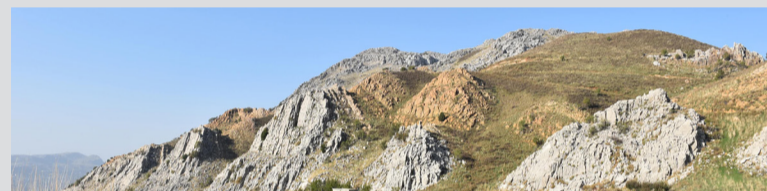
The Lebanon Mountain Trail (LMT) is the first long-distance hiking trail in Lebanon. It extends from Andqet in the north to Marjaayoun in the south, a 450 km (280 miles) path that transects more than 75 towns and villages at altitudes ranging from 570m to 2,073m - about 1,870 to 6,800 feet - above sea level. The LMT showcases the natural beauty and cultural wealth of Lebanon's mountains and demonstrates the determination of the people of Lebanon to conserve this unique heritage. The trail brings communities closer together and expands economic opportunities in rural areas through environmentally and socially responsible tourism.

A- EHMEJ - EL AAQOURA

On the section of Ehmej-El Aaqoura, you will go through different geological times from Jurassic (180 Ma) to Cretaceous (Cenomanian-100.5 and 93.9 Ma). These beds have been folded (bent) because of a late structural tectonic deformation leading to the beds having an inclination with respect to the horizontal.

The beds become more horizontal as you move towards the East towards the highest parts of Mount Lebanon. On the way, you will pass by a cave developed in limestone and observe the relationship between agriculture and geology on basaltic terrains. The trail ends with the landslides of El Aaqoura.

Trail Direction	Total Length	Total Ascent	Total Descent	Duration	Difficulty Level
El Mathkouba - El Ouata	3.5km	209m	356m	2h	Difficult
Type of terrain	Dirt road, goat trail, footpath				



B- EHMEJ - BALOUAA BAATARA

On the section of Ehmej- Balouaa Baatara, you will go through different geological times from Jurassic (180 Ma) to Basal Cretaceous (145 Ma). The Jurassic beds start with limestone and dolostone (limestone rich in Magnesium), then a basaltic layer due an episode of volcanism, then limestone of about 140 Ma of age. During the Jurassic, all these layers deposited below the sea. Later, you will pass through a rock formation composed of sandstone deposited in a fluvial network. The latter indicates that Lebanon during these times emerged from below the sea. The beds have been folded (bent) because of a late structural tectonic deformation leading to the beds having an inclination with respect to the horizontal.

Trail Direction	Total Length	Total Ascent	Total Descent	Duration	Difficulty Level
Ehmej - Balouaa Baatara	6km	241m	274m	2h 30m	Difficult
Type of terrain	Dirt road, goat trail, footpath				



C- JAJ NATURE RESERVE

The Jaj Nature Reserve Geotrail Loop is a perfect example of an amazingly developed karst landscape. On this section you will see a grayish landscape made up of dissolved limestone resulting into various surface sculpted forms. This landscape is referred to as Karst (German form of a Slovene word meaning bare stony ground) that describes limestone terrain characterized by a stony ground (sometime rough and edgy), a lack of surface water drainage, and a discontinuous or thin soil cover.

Trail Direction	Total Length	Total Ascent	Total Descent	Duration	Difficulty Level
Jaj Nature Reserve	5km	369m	384m	2h 30m	Difficult
Type of terrain	Footpath				



D- JORD EL AAQOURA

From the section Afqa El Aaqoura and El Aaqoura Tannourine, you will be going through rocks of Albian-Cenomanian age (113 to 100.5 Ma). The rocks are composed of thinly bedded dolomitic limestone and limestone. You will hike on a vast plateau with multiple small round asymmetrical depression in the land surface: these are called dolines. They are the result of dissolution of limestone beneath the surface and the collapse of weakened rocks leading to depressions in the land surface. These depressions may be filled by up to 5 m of soil. On the way, you will pass through a phenomenal panoramic view showing the different geological rock layers.

Trail Direction	Total Length	Total Ascent	Total Descent	Duration	Difficulty Level
Jord El Aaqoura	11.3km	589m	589m	5h	Challenging
Type of terrain	Dirt road, goat trail				



LMT BLAZING CODES

	LMT	Side Trail	Connecting Trail	Network Trail
Go straight				
Turn left				
Turn right				
Wrong direction				
End/ beginning of trail				

GEOTHEMES & KEYWORDS

1. DEPOSITION AND DIAGENESIS

Defines the environments of deposition of certain sediments and the process of lithification (when sediments turn into a rock). Diagenesis processes show how a formed rock is altered chemically or physically at later stages during its formation and burial. E.g. limestone rock that makes up more than 67% of Lebanese strata.

E.g. Dolomite (magnesium rich calcium carbonate) along Ehmej Balouaa Baatara geotrail

4. KARST LANDSCAPES

Karst landscapes are the result of dissolution by carbonation of limestone (slightly acidic waters) percolating into the subsurface. The different shapes seen in the surface and subsurface constitute a karst landscape. Karst comes from Kras (Slovene word) for bare stony ground.

E.g. Lapias (karst towers) along Jaj Nature Reserve geotrail

7. SPRINGS AND GROUNDWATER

Springs are emerging groundwater and a very important resources of fresh water. Groundwater flows into the subsurface and emerges at locations where there is an impermeable layer or along a crack.

E.g. Nabaa AchChahahir Spring along Ehmej Balouaa Baatara geotrail

10. MASS WASTING & EROSION

Geological material that is prone to a loss of stability because of excessive weathering and weakening, and present on unsuitable slopes may fail and cause variable types of mass wasting (called locally landslides).

E.g. El Aaqoura Earth Flow along Ehmej El Aaqoura geotrail

2. GEOLOGICAL STRUCTURES (FOLDS & FAULTS)

Geological structures refer to mechanical deformation of rocks (brittle or ductile) that either leads to a visible crack in the rock where movement occurs (fault), or to a bending of the strata at a certain angle to the horizontal (fold). These structures are the result of tectonic stresses.

E.g. Bended rock sequence along Ehmej El Aaqoura geotrail

5. FOSSILIZATION

Fossils are large to small organisms that deposited simultaneously with sediments in the environment of deposition. When fossils are marine, they indicate that the rock was deposited under the sea.

E.g. Recrystallized fossils (bivalves) rocks of Jurassic age along Jaj Nature Reserve geotrail

8. SOCIO-GEOLOGY

This theme illustrates the relationship between geology and anthropology, where basaltic soils are used for agriculture, because of their fertile and mineral properties.

E.g. Terraces developed in volcanic soil along Aalmat geotrail

11. WEATHERING

Weathering can be both mechanical and chemical. On the trails you will see a chemical alteration of a rock (oxidation will give the rock a brownish color), while roots penetrating into a rock fissure will crack it further leading to mechanical weathering.

E.g. Chemical weathering: dissolution by waters rich in carbonic acid (slightly acidic) along Jaj Nature Reserve geotrail

3. CAVES

Caves form as a result of dissolution of limestone by slowly flowing groundwater. With time fissures will be further enlarged, leading to conduits forming the main cave with its tributaries.

E.g. El Mathkouba Cave along Ehmej El Aaqoura geotrail

6. VOLCANISM AND MAGMATISM

There were episodes of magmatism in Lebanon (Jurassic, Cretaceous and recent time period). Lava erupted along fissures and deposited basalts of different colors varying from brown, red, to black.

E.g. Basalt indicative of volcanism along Ehmej Balouaa Baatara geotrail

9. GEOLOGICAL TIMES

Geological times are marked by the deposition of different rock types and different geological processes. This theme relates observed rock types and geological phenomenon to time (generally from Jurassic (180 Ma), to recent)

E.g. Geological rock sequence along Ehmej Balouaa Baatara geotrail

12. LIMESTONE DEPOSITION

¹ Limestone is the most common type of rock found in Lebanon. Limestone forms biogenically by the settling and recrystallization of foraminiferal skeletons (average size 10-100 µm) in the sea. These microorganisms build their skeleton using calcium and bicarbonate from sea water. Therefore, limestone is indicative of deposition below the sea (to the exception of charophytes that deposit in fresh water lakes and lead to limestone deposition as well)

DISCLAIMER

The Lebanon Mountain Trail Association (LMTA) recognizes that hiking, trekking, mountain biking and climbing are activities with danger of personal injury or death. Participants in these activities should be aware of, and accept these risks and be responsible for their own actions. Also, the LMTA is not responsible for any health hazard resulting from using or drinking of any water source on the trail.

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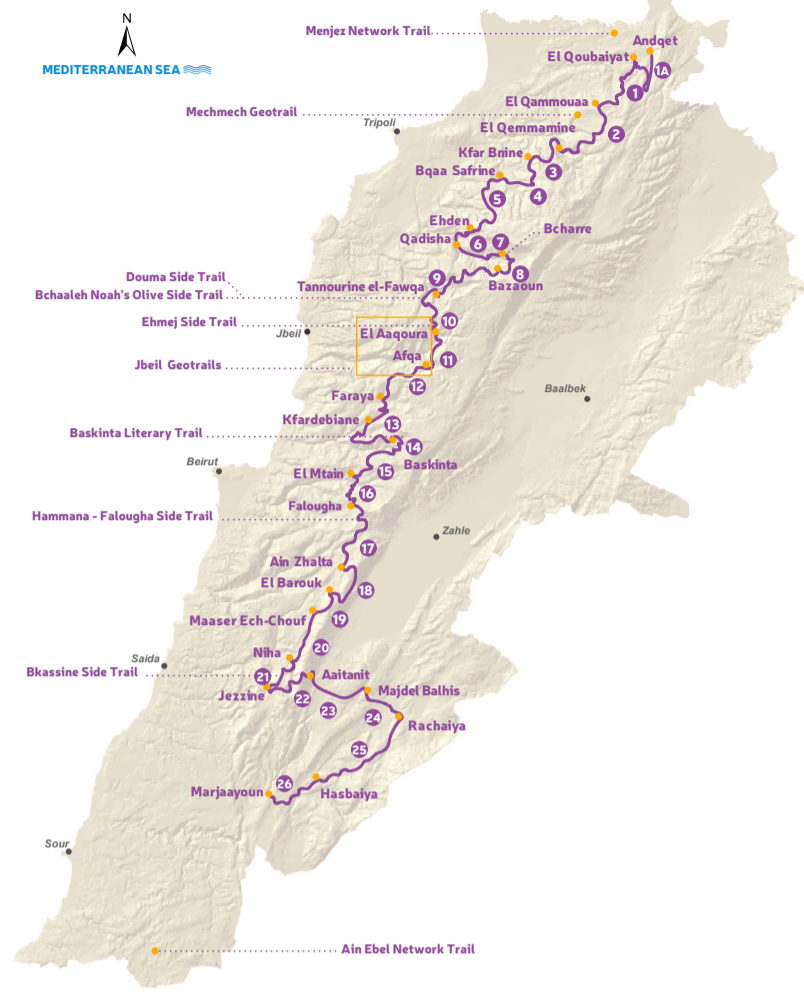
EMERGENCY NUMBERS

Red Cross: 140

Police: 112

Civil Defence: 125

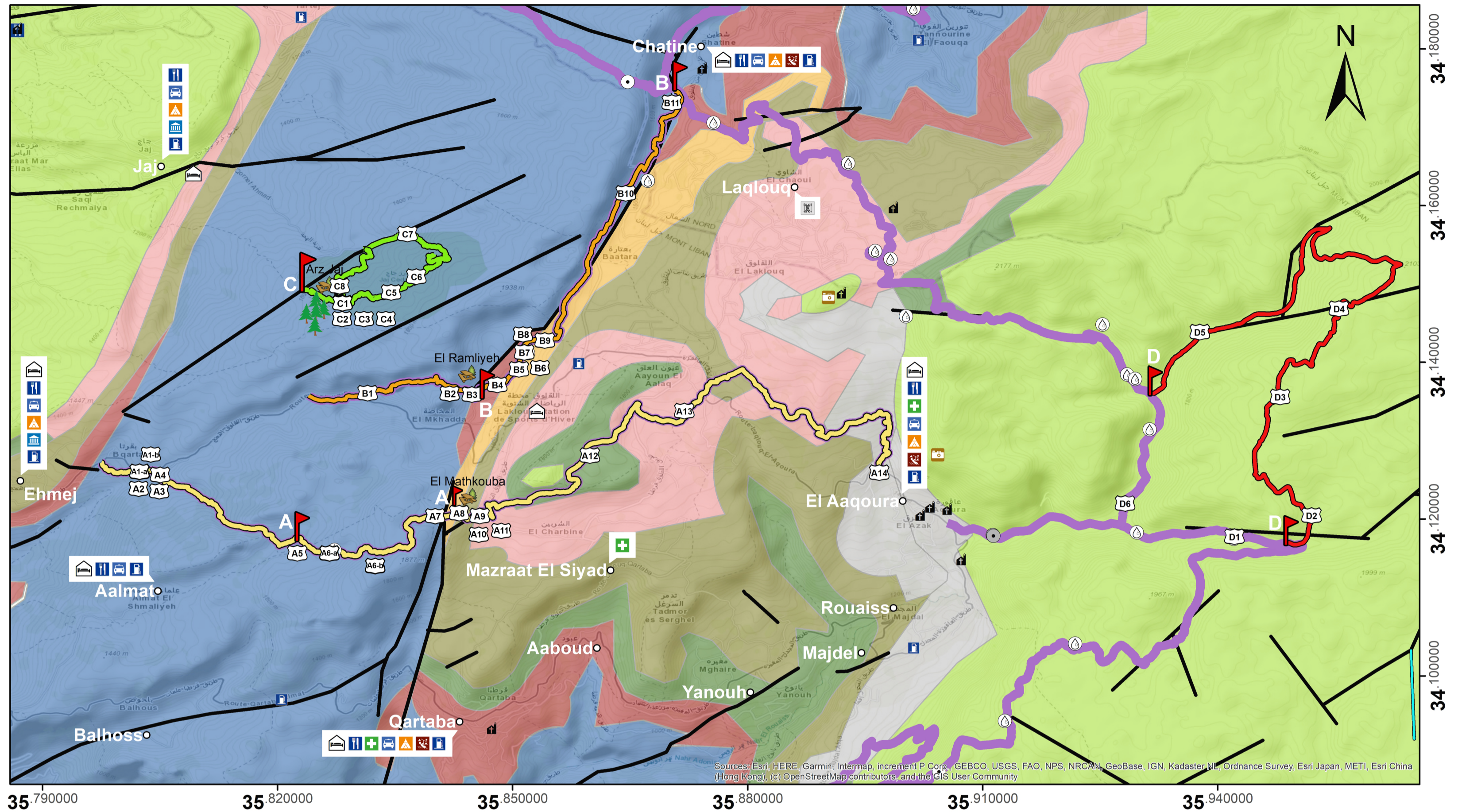
JBEIL GEOTRAILS



These trails were made possible through the United Nations Development Programme (UNDP) and the Ministry of Environment of Lebanon with the generous funding from the Global Environment Facility (GEF).



JBEIL GEOTRAILS



Legend

- Scenic view
- Church
- Roman ruins
- Protected Area
- Spring
- Fuel Station
- Accommodation
- Rest Area
- Restaurant
- Panoramic View
- Water Fall
- Geosites
- Start of Trail
- Pharmacy
- Taxi
- Museum
- Camping Site
- Adventure Park
- Ski Slope
- A- Ehmej-El Aaqoura Geotrail
- B- Ehmej- Balouaa Baatara Geotrail
- C- Jaj Nature Reserve Geotrail
- D- Jord El Aaqoura Geotrail
- Lebanon Mountain Trail
- Villages
- Faults

Lithology

- Formation Name- Age - Description**
- Quaternary: (Recent since 2.6 my) Q Landslides (creep, earth flow and rock fall)
 - Albian-Cenomanian (113.0 and 93.9 my): C4 Dolostone and limestone
 - Upper Aptian (121.4-113.0 my): C3 Marls
 - Upper Aptian (121.4-113.0 my): BC3 Volcanics
 - Lower Aptian (121.4-113.0 my): C2 Marls, sandy limestone and limestone cliff
 - Hauterivian-Barremian (132.6-121.4): C1 Basalts and sandstone
 - Middle Jurassic (152.1-145.0 my): J5 Basalts
 - Early to late Jurassic (201.3-145.0 my): J4-J6: Limestone diagenetic dolostone and volcanics

Geotrails Sections and Geosites

A- Ehmej El Aaqoura		3.5 km		Difficult	
A1-a	Inclined beds	A7	Spring Nabaa Bouhmar		
A1-b	Fractures	A8	Inclined beds		
A2	Stream and Ain Nassouh Spring	A9	Inclined beds and structures		
A3-a	Mechanical weathering	A10	Agriculture ponds in basalts		
A3-b	Dolomitization and diagenesis	A11	El Mathkouba Cave		
A4	Bioturbation	A12	Doline and Karstification		
A5	Limestone (Jurassic age)	A13	Basalts ponds in agriculture		
A6-a	Doline Bouhmar	A14	El Aaqoura Landslide		
A6-b	El Tellaj				

B- Ehmej Balouaa Baatara		6 km		Difficult	
B1	Dolomite	B7	Panoramic view on geo-logical layers		
B2	Sandy Dolomite at El Ramliyah	B8	Nabaa Echchahrir Spring		
B3	Dolomite	B9	Contact Basalts - Limestone		
B4	A Journey through geological times	B10	Contact Jurassic & Cretaceous		
B5	Contact Dolostone - Basalts	B11	Balouaa Baatara Sinkhole		
B6	Inclined beds and fault				

C- Jaj Nature Reserve		5 km		Difficult	
C1	Fractures				
C2	Recrystallized fossils				
C3	Lapiaz (Karst)				
C4	El Manchra sinkhole				
C5	Cave				
C6	Doline al Hasak				
C7	Dyke and dolomite				
C8	Calcite Crystals				

D- Jord El Aaqoura		11.3 km		Challenging	
D1	Ain El Asafir				
D2	Doline				
D3	Dry Valley				
D4	Doline				
D5	Ain El Lebne Cave				
D6	Volcanic ponds				

