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Chapter 1 : Mediterranean was created in Earth's biggest deluge | Science | The Guardian

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Based on the work of M. McMahon at the University of Melbourne. The Mediterranean basin covers portions of three continents: Europe , Asia , and Africa It has a varied and contrasting topography. The Mediterranean Region offers an ever-changing landscape of high mountains, rocky shores, impenetrable scrub, semi-arid steppes, coastal wetlands, sandy beaches and a myriad islands of various shapes and sizes dotted amidst the clear blue sea. Contrary to the classic sandy beach images portrayed in most tourist brochures, the Mediterranean is surprisingly hilly. Mountains can be seen from almost anywhere. It includes the Mediterranean climate Levant at the eastern end of the Mediterranean, bounded on the east and south by the Syrian and Negev deserts. The northern portion of the Maghreb region of northwestern Africa has a Mediterranean climate, separated from the Sahara Desert , which extends across North Africa , by the Atlas Mountains. In the eastern Mediterranean the Sahara extends to the southern shore of the Mediterranean, with the exception of the northern fringe of the peninsula of Cyrenaica in Libya , which has a dry Mediterranean climate. Europe lies to the north, and three large Southern European peninsulas, the Iberian Peninsula , Italian Peninsula , and the Balkan Peninsula , extend into the Mediterranean-climate zone. A system of folded mountains, including the Pyrenees dividing Spain from France , the Alps dividing Italy from Central Europe , the Dinaric Alps along the eastern Adriatic , and the Balkan and Rhodope mountains of the Balkan Peninsula divide the Mediterranean from the temperate climate regions of Western and Central Europe. Geology and paleoclimatology[edit] The Mediterranean Basin was shaped by the ancient collision of the northward-moving African-Arabian continent with the stable Eurasian continent. As Africa-Arabia moved north, it closed the former Tethys Sea , which formerly separated Eurasia from the ancient super continent of Gondwana , of which Africa was part. At about the same time, mya in the Jurassic period, a small Neotethys ocean basin formed shortly before the Tethys Sea was closed at the eastern end. The collision pushed up a vast system of mountains, extending from the Pyrenees in Spain to the Zagros Mountains in Iran. This episode of mountain building, known as the Alpine orogeny , occurred mostly during the Oligocene 34 to 23 million years ago mya and Miocene 23 to 5. The Neotethys became larger during these collisions and associated folding and subduction. About 6 mya during the late Miocene, the Mediterranean was closed at its western end by drifting Africa, which caused the entire sea to evaporate. There followed several debated episodes of sea drawdown and re-flooding known as the Messinian Salinity Crisis , which ended when the Atlantic last re-flooded the basin at the end of the Miocene. Recent studies, however, show that repeated desiccation and re-flooding is unlikely from a geodynamic point of view. Fossil evidence shows that the Mediterranean Basin had a relatively humid subtropical climate with summer rainfall during the Miocene, which supported laurel forests. The shift to a Mediterranean climate occurred within the last 3. The subtropical laurel forests retreated, although they persisted on the islands of Macaronesia off the Atlantic coast of Iberia and North Africa, and the present Mediterranean vegetation evolved, dominated by coniferous trees and sclerophyllous trees and shrubs, with small, hard, waxy leaves that prevent moisture loss in the dry summers. Much of these forests and shrublands have been altered beyond recognition by thousands of years of human habitation. There are now very few relatively intact natural areas in what was once a heavily wooded region. Flora and fauna[edit] Phytogeographically , the Mediterranean basin together with the nearby Atlantic coast, the Mediterranean woodlands and forests and Mediterranean dry woodlands and steppe of North Africa , the Black Sea coast of northeastern Anatolia , the southern coast of Crimea between Sevastopol and Feodosiya and the Black Sea coast between Anapa and Tuapse in Russia forms the Mediterranean Floristic Region, which belongs to the Tethyan Subkingdom of the Boreal Kingdom and is enclosed between the Circumboreal , Irano-Turanian , Saharo-Arabian and Macaronesian floristic regions. The Mediterranean Region was first proposed by German botanist August Grisebach in the late 19th century. Drosophyllaceae , recently segregated from Droseraceae , is the only plant family endemic to the region. Among the endemic plant genera are:

Chapter 2 : Island isolation, warming climate shape Mediterranean Basin evolution â€“ #FloridaMuseumSc

The Mediterranean Sea, nestled between Africa, southern Europe, and the Middle East, may be envisioned as a complex picture-puzzle comprising numerous intricate pieces, many of which are already in place. A general image, in terms of science, has emerged, although at this time large gaps are noted.

This is related to research of our own group here at CSIC 1. Classical authors such as Aristotle, Galileo, or Leonardo da Vinci, used to describe the birth of the Mediterranean Sea as an enormous flood through the Strait of Gibraltar that filled a desiccated basin. All such stories can be traced back to the 3rd volume of the oldest known encyclopedia: Historia Naturalis 1st century AD. Amazingly enough, the geophysical and geological research carried out in the last decades seems to support this ancient vision about the origins of the Mediterranean Sea. Since the identification of the Messinian age by Austrian naturalist Karl Mayer late nineteenth century we know that the marine connections between the Mediterranean Sea and the Atlantic Ocean became small by the end of the Miocene. Modern chronostratigraphy has dated this at 6 million years ago, the time when our earliest ancestors started walking on two legs in Central Africa. The ongoing tectonic uplift of the Gibraltar Arc region finally emerged the last Atlantic seaway and isolated completely the Mediterranean from the ocean, about 5. The Mediterranean then became largely evaporated as a result of the dry climate of its watershed. The indications that this occurred geologically very fast namely, the abrupt change from Miocene to Pliocene sedimentary layers made this event be known as the Zanclean flood. The flood along the Gibraltar threshold may have been caused by its subsidence below the Atlantic level, or by faulting, or by erosion or a combination of these three proposed mechanisms. But beyond the causes for the flood, another key unknown is the nature, abruptness and evolution of the flood itself: From the sharp transition in the sedimentary layer record, it is widely thought though not unanimously that the event was very fast. But in geology fast can mean a hundred thousand years. Because little was known about its dynamics, and perhaps because for geologists rapid major events are rare and challenge the principle of uniformitarianism , the flood duration underwent a wide range of estimations from tens to tens of thousands of years. Simulation of the refill through the strait of Gibraltar by Steven N. Note the water velocity distribution around 1: Before knowing anything about the Messinian Mediterranean, I used to model the evolution of landscape over geological time scales. I was particularly interested on the role of lakes in controlling the long-term evolution of topography of large continental regions. Lakes are those water bodies collecting precipitation in local topographic minima. Lakes are usually ephemeral over geologic timescales: Unless there is a tectonic process enlarging that topographic basin, they soon fill up with sediment, overspilling their banks. In our landscape evolution models this transition was systematically very fast, but this result was not convincing enough for two reasons: First, lake data to compare with were scarce, and we were in the need of a large case scenario where traces of erosion were more evident. Secondly, our models where not accounting for transitory water flow, but instead it was calculating a steady flow i. Evolution of a tectonic lake formed in front of a growing tectonic barrier. Garcia-Castellanos, , GSA spec. It struck me that the feedback between water flow and incision we envisaged for lakes should be similar during the Zanclean flood, seeing the global ocean as a huge lake on the verge of overtopping towards the dry Mediterranean. Combining the formulation of river incision with the proper hydrodynamic equations, we built a simple but robust mathematical formulation for overtopping floods. We used then erosional parameters derived from the study or mountain river incision, and then incorporated a reconstruction for the Mediterranean seafloor geometry. Then we started running virtual floods. The first results were so surprising that we thought something was probably wrong with the code. Things were happening much faster than in those lake scenarios we were used to. The Mediterranean was filling in only a few years, and a large erosion channel excavated across the Strait of Gibraltar, some hundred meters deep. Unfortunately, we did not know enough about the erodibility of rocks to be able to have conclusive results. But if that was correct, we should be able to find traces of the flood erosion preserved under the sedimentary layers in the strait. So we turned to previously published research and found two pieces of evidence: The first was a vintage seismic image showing a cross-section of the sedimentary layers near the strait area 3. The second piece of evidence came from cores of rock drilled from the strait area as part of the exploration for the Africa-Europe tunnel project that would build a train connection between Spain and Morocco 4. These cores also showed a channel deeper than m, wider than 3 km, and filled with post-Messinian sediment. Altogether, the documented erosion valley connecting the Eastern Atlantic to the Western Mediterranean is more than kilometre long. If this were a result of fluvial erosion, it would be strange to find erosion on both sides of the present water divide between Atlantic and Mediterranean. Furthermore, rather than a waterfall over the Gibraltar Strait as previously suggested, the seismic data show a huge ramp, several kilometres wide descending rather gradually from the Atlantic to the Mediterranean. With these data, we turned again to the models. Using the observed erosion depth and width as a constrain, the model estimated now that the flood may have began slowly, taking up to several thousand years before a significant rise in Mediterranean level occurred. To fit the observations, the flooding channel had to cut down into the bedrock almost half a metre per day, leading to a large inlet flow that would increase the Mediterranean sea level by more than 10 metres per day. The technique does not allow constraining the way and speed of the initial stages. This means that the initial trigger may have been a geologically modest event such a large storm, a tsunami, or a partial collapse of the dividing barrier. Possible evolution of the flood according to one of the models. The Zanclean flood involved an order of magnitude more water flow than the megafloods that we know took place during the last deglaciation e. The implications of such a rapid flooding are inevitably big: Global flora and fauna had to adapt to the new environmental conditions rapidly. Marine species colonized a huge new realm rapidly whereas for land species, particularly in islands, the flooded Mediterranean became a sudden barrier triggering speciation. Had the land connection remained, it could have facilitated an earlier arrival of early humans in western Europe. The Messinian salinity crisis also highlights the importance of seaways in understanding the geological record: The flood may also have had tectonic implications: The weight of the flooding waters is such that it should have modified the rotation of the Earth, and it should have made the entire Mediterranean region sink by at least one kilometer in the mantle, according to the principle of Isostasy. Also global climate surely must have been impacted by the Messinian salinity crisis and its rapid ending, but so far this is perhaps the most elusive aspect of the crisis, something remarkable since I am not aware of other scenarios in geological history where the climatic response to such a large environmental change can be better tested. So there are plenty of open questions on the Zanclean Flood that need an answer. Video on the Atlantropa Project, showing the collapse of a projected dam across the Strait of Gibraltar. Catastrophic flood of the Mediterranean after the Messinian salinity crisis. Nature , doi: Long-term evolution of tectonic lakes: Climatic controls on the development of internally drained basins. Tectonics, Climate, and Landscape evolution. GSA Special Paper Late Miocene to recent, Geo Mar. The opening of the Plio-Quaternary Gibraltar Strait:

Chapter 3 : How the Mediterranean was refilled - Mapping Ignorance

Geological Evolution of the Mediterranean Basin Raimondo Selli Commemorative Volume Edited by Daniel Jean Stanley Forese-Carlo Wezel With Figures.

In , he named the period the Messinian after the city of Messina in Sicily , Italy. This feature, dubbed the M reflector, closely followed the contours of the present seafloor, suggesting that it was laid down evenly and consistently at some point in the past. The origin of this layer was largely interpreted as related to salt deposition. However, different interpretations were proposed for the age of salt and its deposition. Earlier suggestions from Denizot in [9] and Ruggieri in [10] proposed that this layer was of Late Miocene age, and the same Ruggieri coined the term Messinian Salinity Crisis. New and high-quality seismic data on the M-reflector were acquired in the Mediterranean Basin in , published by e. Ryan and Kenneth J. These deposits were dated and interpreted for the first time as deep-basin products of the Messinian Salinity Crisis. Cones of gypsum , which formed on the sea floor as a result of evaporation. The scale of gypsum formation in the Sorbas basin Yesares member. The upward-growing cones suggest precipitation on the sea floor not within sediments. The first drilling of the Messinian salt at the deeper parts of the Mediterranean Sea came in the summer of , when geologists aboard the Glomar Challenger brought up drill cores containing arroyo gravels and red and green floodplain silts; and gypsum , anhydrite , rock salt , and various other evaporite minerals that often form from drying of brine or seawater, including in a few places potash , left where the last bitter, mineral-rich waters dried up. One drill core contained a wind-blown cross-bedded deposit of deep-sea foraminiferal ooze that had dried into dust and been blown about on the hot dry abyssal plain by sandstorms , mixed with quartz sand blown in from nearby continents, and ended up in a brine lake interbedded between two layers of halite. These layers alternated with layers containing marine fossils, indicating a succession of drying and flooding periods. The massive presence of salt does not require a desiccation of the sea. In the Western Mediterranean series, the presence of pelagic oozes interbedded within the evaporites suggests that the area was repeatedly flooded and desiccated over the course of , years. This episode comprises the second part of what is called the "Messinian" age of the Miocene epoch. This age was characterised by several stages of tectonic activity and sea level fluctuations, as well as erosional and depositional events, all more or less interrelated van Dijk et al. The basin was finally isolated from the Atlantic Ocean for a longer period, between 5. During the initial, very dry stages 5. This suggests either a succession of desiccations or a long period of hypersalinity during which incoming water from the Atlantic Ocean was evaporated with the level of the Mediterranean brine being similar to that of the Atlantic. The nature of the strata points strongly to several cycles of the Mediterranean Sea completely drying and being refilled Gargani and Rigollet, [4] , with drying periods correlating to periods of cooler global temperatures; which were therefore drier in the Mediterranean region. The oldest sediment of each cycle was either deposited in a deep sea or in a great brackish lake. The fine sediments deposited on a quiet or deep bottom had perfectly even lamination. As the basin was drying up and the water depth decreased, lamination became more irregular on account of increasing wave agitation. Stromatolite was formed then, when the site of deposition fell within an intertidal zone. The intertidal flat was eventually exposed by the final desiccation, at which time anhydrite was precipitated by saline ground water underlying sabkhas. Suddenly seawater would spill over the Strait of Gibraltar , or there would be an unusual influx of brackish water from the eastern European lake. The Balearic abyssal plain would then again be under water. The chicken-wire anhydrite would thus be abruptly buried under the fine muds brought in by the next deluge. Hsu, [23] Research since then has suggested that the desiccation-flooding cycle may have repeated several times [24] [25] during the last , years of the Miocene epoch. This could explain the large amount of salt deposited. Recent studies, however, show that the repeated desiccation and flooding is unlikely from a geodynamic point of view. Evaporites pink were deposited in landward basins first, and closer to the Atlantic as the extent of the Mediterranean Sea dark blue diminished towards the gateway. The light blue shows the original sea level. Synchronous deposition in marginal basins. Sea level drops slightly, but the whole basin is still connected to the Atlantic. Reduced inflow allows the accumulation of evaporites in shallow basins only. Closure or restriction of the Atlantic seaway by tectonic activity dark grey causes evaporite deposition simultaneously across the entire basin; the basin may not need to empty completely, as salts are concentrated by evaporation. Some major questions remain concerning the beginning of the crisis in the central Mediterranean Basin. The geometric physical link between the evaporitic series identified in marginal basins accessible for field studies, such as the Tabernas basin and Sorbas basin , and the evaporitic series of the central basins has never been made. Using the concept of deposition in both shallow and deep basins during the Messinian i. This model would suggest that the sea level of the whole Mediterranean basin fell at once, but only shallower basins dried out enough to deposit salt beds. As highlighted in the work of van Dijk [29] and van Dijk et al. They also questioned again like some previous authors had done, whether the basins now observed as "deep" were actually also deep during the Messinian Episode and gave different names to the end-member scenarios described above. Distinguishing between these hypotheses requires the calibration of gypsum deposits. Gypsum is the first salt calcium sulphate to be deposited from a desiccating basin. Magnetostratigraphy offers a broad constraint on timing, but no fine detail. Therefore, cyclostratigraphy is relied upon to compare the dates of sediments. The typical case study compares the gypsum evaporites in the main Mediterranean basin with those of the Sorbas basin , a smaller basin on the flanks of the Mediterranean Sea that is now exposed in southern Spain. The relationship between these two basins is assumed to represent the relationships of the wider region. Recent work has relied on cyclostratigraphy to correlate the underlying marl beds, which appear to have given way to gypsum at exactly the same time in both basins Krijgsman, In order to refute it, it is necessary to propose an alternative mechanism for generating these cyclic bands, or for erosion to have coincidentally removed just the right amount of sediment everywhere before the gypsum was deposited. The proponents claim that the gypsum was deposited directly above the correlated marl layers, and slumped into them, giving the appearance of an unconformable contact. This would result in the Sorbas basin being filled with evaporites at 5. Recent works have highlighted a pre-evaporite phase corresponding to a prominent erosional crisis also named " Messinian erosional crisis "; the termination of the "Mes-1" unconformity bound depositional sequence of van Dijk, [29] responding to a major drawdown of the Mediterranean seawater. Regarding these works, a deep water formation seems unlikely. The assumption that central basin evaporites partly deposited under a high bathymetry and before the major phase of erosion should imply the observation of a major detritic event above evaporites in the basin. Such a depositional geometry has not been observed on data. This theory corresponds to one of the end-member scenarios discussed by van Dijk et al. While there is disagreement on all fronts, the most general consensus seems to agree that climate had a role in forcing the periodic filling and emptying of the basins, and that tectonic factors must have played a part in controlling the height of the sills restricting flow between the Atlantic and Mediterranean Gargani and Rigollet, In that area, one of the tectonic boundaries between the African Plate and the European Plate and its southern fragments such as the Iberian Plate , is located. This boundary Zone is characterised by the presence of an arc shaped tectonic feature, the Gibraltar Arc , which includes southern Spain and northern Africa. In the present day area of the Mediterranean Sea, three of these arc shaped belts are present: The kinematics and dynamics of this plate boundary and of the Gibraltar Arc during the late Miocene are strictly related to the causes of the Messinian Salinity Crisis: Tectonic reconfiguration may have closed and re-opened passages; the region where the connection with the Atlantic Ocean was situated is permeated by strike-slip faults and rotating blocks of continental crust. However, the precise tectonic activity behind the motion can be interpreted in a number of ways. An extensive discussion can be found in Weijermars Shortening and extension occur at the same time in close proximity; sedimentary sequences and their relations to fault activity constrain the rates of uplift and subsidence quite precisely Fault-bounded continental blocks can often be observed to rotate The depth and structure of the lithosphere is constrained by records of seismic activity, as well as tomography The composition of igneous rocks variesâ€”this constrains the location and extent of any subduction. The same features can be explained by regional delamination [38] or the loss of a layer of the entire lithosphere. However, it is difficult to fit it with the pressure and temperature histories of some metamorphic rocks Platt et al. They occur during cool periods of Milankovic cycles , when less solar energy reached the northern hemisphere. This led to less evaporation of the North Atlantic, hence less rainfall over the Mediterranean. This would have starved the basin of water supply from rivers and allowed its desiccation. The lack of ice caps at the time means there was no realistic mechanism to cause significant changes in sea levelâ€"there was nowhere for the water to go, and the morphology of ocean basins cannot change on such a short timescale. There is no situation on Earth directly comparable to the dry Mediterranean, and thus it is not possible to know its climate. There is not even a consensus as to whether the Mediterranean Sea even dried out completely; it seems likeliest that at least three or four large brine lakes on the abyssal plains remained at all times. The extent of desiccation is very hard to judge due to the reflective seismic nature of the salt beds, and the difficulty in drilling cores, making it difficult to map their thickness. Nonetheless, one can study the forces at play in the atmosphere to arrive at a good speculation of the climate. As winds blew across the "Mediterranean Sink ", they would heat or cool adiabatically with altitude. In the empty Mediterranean Basin, the summertime temperatures would probably have been extremely high even during the coldest phase of any glacial era. Although it was probably quite dry in the Basin, there is no direct way to measure how much drier it would have been compared to its surroundings. Areas with less severe depths would probably have been very dry. Today the evaporation from the Mediterranean Sea supplies moisture that falls in frontal storms, but without such moisture, the Mediterranean climate that we associate with Italy, Greece, and the Levant would be limited to the Iberian Peninsula and the western Maghreb. Climates throughout the central and eastern basin of the Mediterranean and surrounding regions to the north and east would have been drier even above modern sea level. The eastern Alps, the Balkans, and the Hungarian plain would also be much drier than they are today, even if the westerlies prevailed as they do now. The Wallachian-Pontic and Hungarian basins were underwater during the Miocene, modifying the climate of what is now the Balkans and other areas north of the Mediterranean basin. The Pannonian Sea was a source of water north of the Mediterranean basin until the middle Pleistocene before becoming the Hungarian plain. Debate exists whether the waters of the Wallachian-Pontic basin and the possibly connected Pannonian Sea would have had access thus bringing water to at least the eastern Mediterranean basin at times during the Miocene. Effects[edit] Effects on biology[edit] Artistic interpretation of the Mediterranean geography during its evaporative drawdown, after complete disconnection from the Atlantic. The rivers carved deep gorges in the exposed continental margins; The concentration of salt in the remaining water bodies led to rapid precipitation of the salt. The inset evokes the transit of mammals e. Play media Messinian salinity crisis animation The Messinian event also provided an opportunity for many African species, including antelopes , elephants and hippopotamuses , to migrate into the empty basin, close to the descending great rivers, to reach interior wetter cooler highlands such as Malta as the sea level was dropping, as such species would not have been able to cross the wide hot empty sink at maximum dryness. North to the left.

Chapter 4 : GEOLOGICAL HISTORY OF THE CENTRAL MEDITERRANEAN BASIN: AN OUTLINE OF CI

The Mediterranean Sea, nestled between Africa, southern Europe, and the Middle East, may be envisioned as a complex picture-puzzle comprising numerous intricate pieces, many of which are already in pl.

Taken on the island of Crete, this photograph shows the typical habitat of bellflowers. But during fieldwork in the Mediterranean Basinâ€"a biodiversity hotspotâ€"she found more questions than answers. The five-year award has resulted in the study of nearly 1, species of bellflowers worldwide, focusing on those restricted to islands in the Mediterranean Basin. The research adds to the work of Charles Darwin and Alfred Russell Wallace, who were the first to notice differences in the geology and biological diversity of continental islands like those in the Mediterranean Basin, which have a past connection with the mainland, and oceanic islandsâ€"those formed by volcanic or tectonic events and rise from the ocean without any history of continental contact. Both types of islands are present in the eastern Mediterranean Basin, a center of diversity for bellflowers. Crete, Karpathos, Kos, Rhodes and other numerous small islands off the west coast of Turkey were once connected to the mainland, while islands like Cyprus rose from the ocean. Because continental islands have been studied less than oceanic islands, little was known about the evolution of endemic lineages of the bellflowers, Cellinese said. He wanted to know more about the evolutionary origins of the Roucela group, or 13 closely related bellflowers found primarily in the eastern Mediterranean Basin. Campanula pinatzii is one of 13 bellflowers of the Roucela group. Florida Museum of Natural History photo by Andrew Crowl The small, herbaceous species with bright purple blooms are rare and restricted to a few islands in the Aegean Archipelago, Cyprus and western Turkey. By reconstructing the evolutionary history of the broader Campanuloidae clade and utilizing the fossil record, Crowl and Cellinese found the group to be much older than previously thought. Molecular dating, diversification and ecological niche modeling techniques were used to establish timing of speciation events and link these to past geologic events in the area. Beginning in the Azores islands and ending along the coast of Turkey, Crowl withstood the dry, hot climateâ€"a climate that evolved from a more subtropical environment and culminated with the onset of the current Mediterranean climate about 2 million years ago. The timing of the evolution of these taxa suggests that they evolved during a time of subtropical climate. Then you get this drying and cooling, and the Roucela group is just not adapted to that. There are many other plants that have evolved and are thriving as the result of the onset of the current Mediterranean environment, Cellinese said. Instead, a balance of plant and animal life already exists on islands when they become isolated from the mainland. However, throughout history, the Mediterranean Sea has risen, fallen and even dried up almost completely as it did during the Messinian Salinity Crisis 5 million years ago. The development of the group was likely the result of ancient geologic and tectonic events that led to numerous cycles of island connection and isolation, Crowl said. The results of his research suggest that the break-up of an ancient Aegean landmass was responsible for driving diversification of these species. Over time, you may end up with new species or extinction. While other researchers have called the bellflowers of the Roucela group rare, Crowl is the first to point out they may actually be in danger of becoming extinct. They may very well become extinct unless we do something.

Chapter 5 : Messinian salinity crisis - Wikipedia

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The development of the Mediterranean basin begins with the breakup of the supercontinent Pangea in the Mesozoic. During this time, sea-floor spreading triggered the development of the Atlantic ocean in the Triassic period, which separated the African and Eurasian plates from the North American plate. Sea-floor spreading in another geographical location caused the development of the Tethys ocean, separating the African plate from the Eurasian. In the late Cretaceous period, these African and Eurasion plates began to converge, closing the Tethys ocean basin, and the remnants of this ancient ocean are now called the Mediterranean sea. There are three major geomorphical settings within the Mediterranean basin; areas with stable margin characteristics, areas with unstable convergent margin charactericstics, and areas with extensional margin rifting characteristics. Thus the Mediterranean basin is a location of an intercontinental interplate system; with compressional and extensional events occurring within close proximity. Geologists have yet to come to a consensus about which plates in addition to the African and Eurasian ones, if any, are involved in Mediterranean tectonics. Subsidence-related and other vertical displacements are also found in compressional and extensional areas. A few notable events occurred during the Cenozoic which affected the entire Mediterranean; the Messinian "salinity crisis", when the closing off of the Mediterranean-Atlantic seaway caused complete isolation of the Mediterranean and thus widespread evaporation; and then the Pliocene "revolution", when the channel opened back up, causing reestablishment of marine conditions; and the Quaternary "transgressive raised terraces," of controversial geological origin; among others. The Central portion of the Mediterranean basin exemplifies the juxtaposition of compressional and extensional tectonic activity in the area. There were four major periods of extension in this area. The first one occurred in the Mid-Upper Jurassic; evidence of this phase is seen in the Strepanosa Trough and Ionian plain. A third extensional phase occurred in the Mid-Upper Cretaceous, as evidenced by the stretched features of the Sirte Rise, a monocline with normal faults and tilted blocks. The fourth one, occurring in the Mid-Upper Miocene through to the Quaternary period, affected many areas of the Central Mediterranean. This extensional phase is closely associated with compressive motions; it is part of the reason for a counter-clockwise rotation of the Southern Appennine area which begins in the upper Cretaceous. All four of these extensional phases are the cause of geologic features found in the area, such as volcanic activity and rift-related sedimentary processes. Due to such extension, the oceanic crusts of the Central Mediterranean are considerably thinned in some places. The Mediterranean Ridge or Outer Median Ridge is a sea-floor feature that marks the ustable convergent margin between two or more oceanic plates geologists know that the African and Eurasian plates are involved, but which, if any, smaller plates are involved is a matter of debate. The first stages of the major collision between the North of the African plate and the South of the Eurasion plate is believed to have occurred in the lower-middle Miocene. It is an extensive fold-fault system corresponding to recent uplift and folding of past abyssal plains. The features in the Adriatic sea are results of this duality of compression as well as extension, and also from deposition-related subsidence on a deeply foundered foreland on the shelf. The Adriatic sea itself is relatively shallow, and almost all of the ocean floor a thick carbonitic platform underlain by continental crust exhibits compressional deformation structures, except for the Ionian Abyssal Plain, which is thought to be underlain by Paleoceanic crust. The history of the Alpine orogeny, constituting the northwestern portion of the Adriatic, really begins in the Mesozoic as well, for the sedimenary strata which constitutes most of its orogenic elements weas laid down in the continental margins of the ancient Tethys ocean. The Alpine orogeny and the Calabrian arc orogeny are both results of convergent plate margin movement between Africa and Europe, and display some vertical uplift associated with the subsidence of Mediterranean sea-floor deposits during the Cenozoic. The Ionian sea perhaps experiences the major amounts of subsidence in the Central Mediterranean. The Ionian Abyssal Plain in this region is characterized by differentially sudbsiding areas but generally experiences more than adjacent regions, contributing greatly to the uplift associated with the Alpine orogeny and the Quaternary coastal blocks. The Hellenic trench a thrust fault linked to the convergent activity in the Mediterranean ridge began propagation in Miocene and continues today; it constitutes a major element of Ionian seafloor topography. The Aegean sea experiences considerable amounts of extensional features as well, related to the suduction of the African plate underneath the Hellenic Arc. Subsidence in the late Miocene also had a grand affect on the region, resulting in the fragmentation of an Aegean landmass from vertical displacement. The outer regions of the Hellenic zones, by conrtast, exhibit compressive geology.

Chapter 6 : Mediterranean Basin - Wikipedia

Stanley & Wezel, Geological Evolution of the Mediterranean Basin, Springer-Verlag, Berckhemer & Hsu, ed; Alpine-Mediterranean Geodynamics, American Geophysical Union, Higgins & Higgins, A Geological Companion to Greece and the Aegean, Cornell University Press,