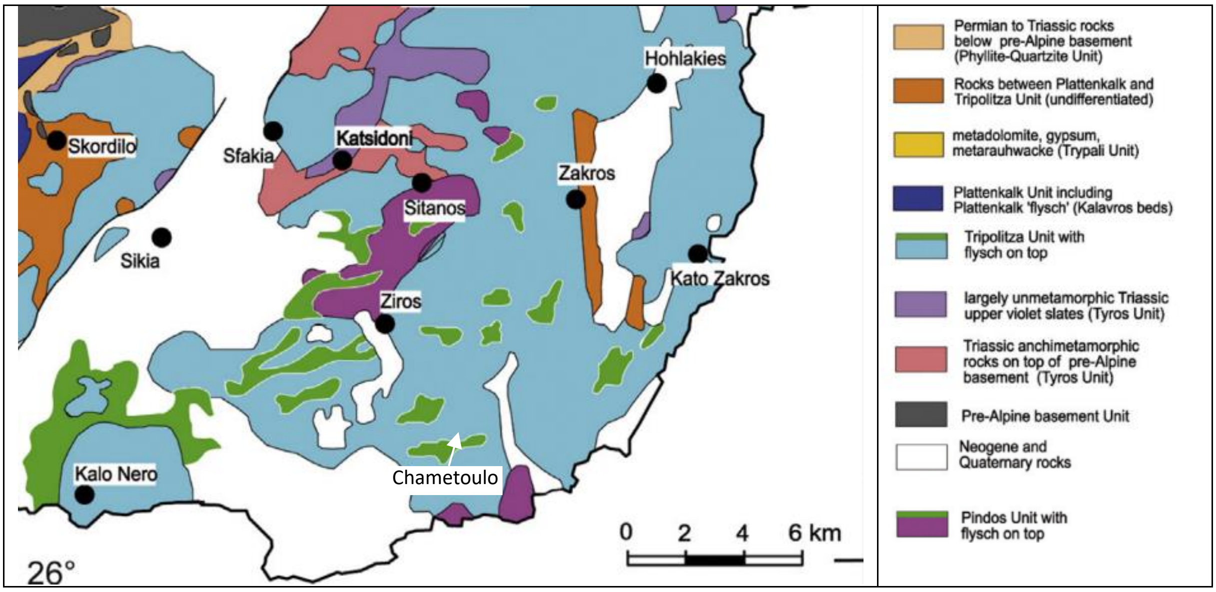
Marine Terraces Miocene Corals and Tripoliza Flysch at Kato Zakros


View of the marine terraces at Kato Zakros looking North

Compiled by George Lindemann, MSc.

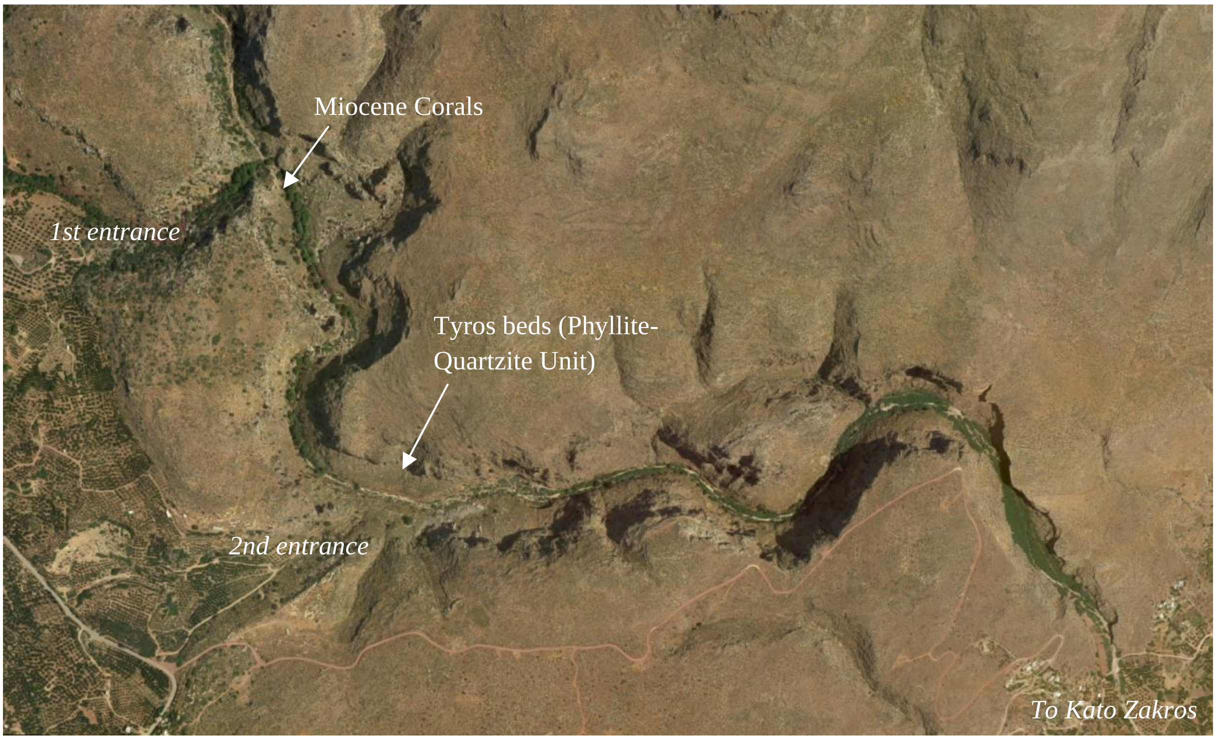
Berlin, August 2023



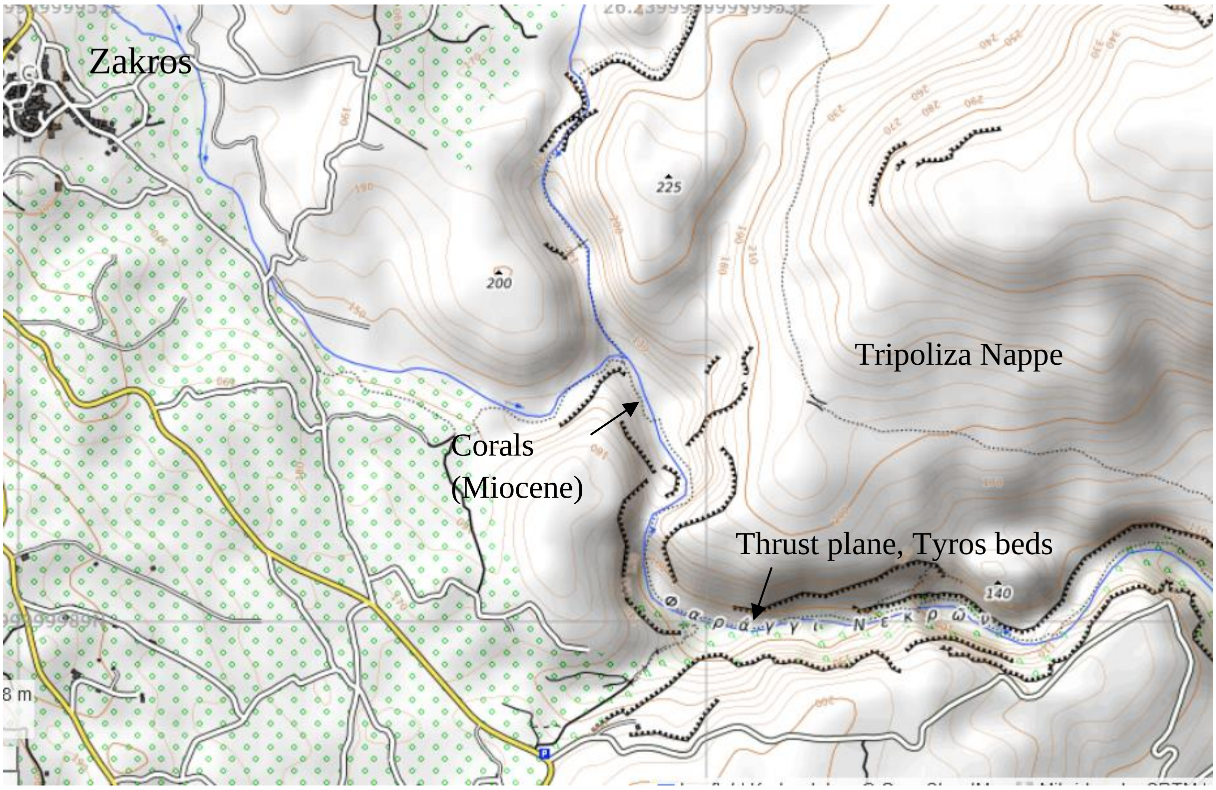
Geological Map of south-eastern Crete [Source: Tonian basement in the eastern Mediterranean, W. Dörr, G. Zulauf et. al.]

Kato Zakros

Zakros Gorge, Miocene Corals and Tripoliza Nappe on Tyros Unit (PQ)



Overview of the Zakros Gorge [Google Maps].



Miocene corals and Tripoliza limestone thrust upon Tyros beds of the Phyllite-Quartzite Unit Southeast of Zakros

Zakros Gorge. 1: Miocene fossils within the Palekastro formation (7-6 million years old), 2: Tripolitza Nappe, 3: Thrust plane Tripoliza on Tyros beds (Phyllite-Quartzite Unit). 2.5 km walk to beach from No.2. and 850m from No. 1 to No. 2 [Google Maps].

View of the Gorge near the Miocene corals looking northwest. The walls of the gorge consist of Trioplitza limestone

Miocene Coral

1: Outcrop of Miocene coral (hammer and rucksack for scale), 2: Tripoliza limestone (Triassic to Eocene)

1: Miocene coral

Closeup of previous picture

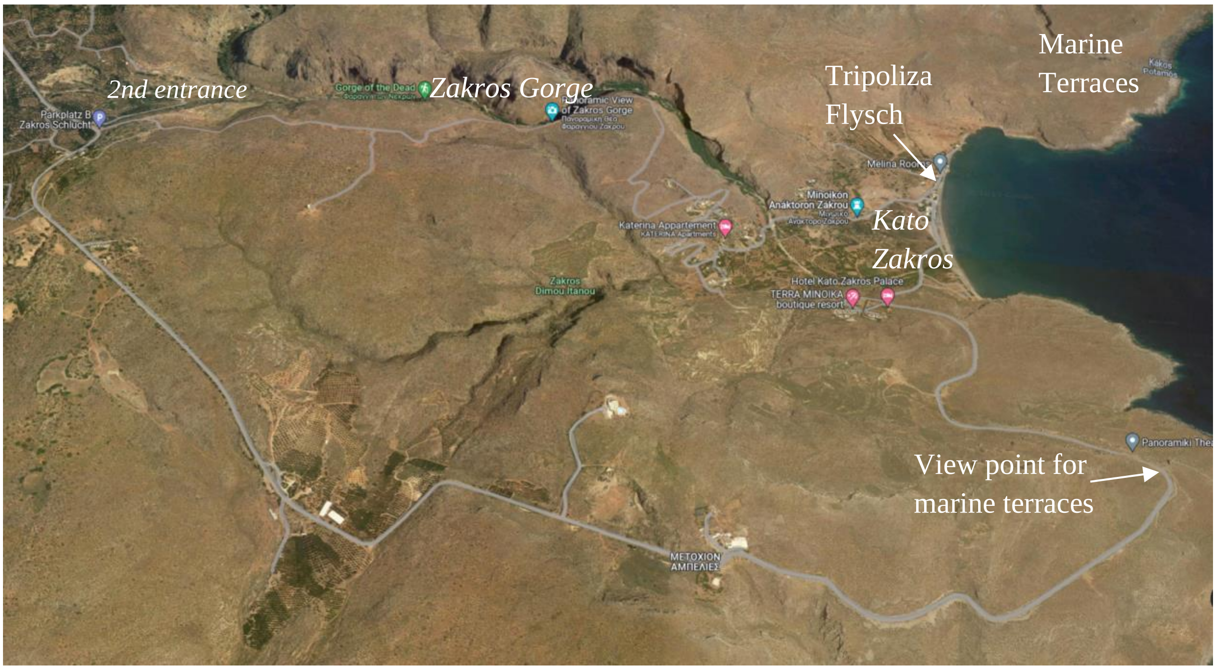
Tripoliza Nappe thrust upon Tyros Beds

The Tyros Unit is overlain by the Tripolitza Unit, which forms a tectonic nappe consisting of middle Triassic to Eocene platform carbonates. The carbonates of the Tripolitza Unit have undergone very low-grade metamorphism (Feldhoff et al., 1991; Rahl et al., 2005; Klein et al., 2008, 2013).

The uppermost beds of the Tyros Unit (also referred to as the Toplou Beds) consist of dark red to violet slates known as the “Upper Violet Slates”. The upper part of the Toplou Beds shows no indication of HP/LT-Metamorphose (Wachendorf et al.) but is regarded to have undergone the lowest grade of metamorphism. The uppermost parts of the Tyros Unit were probably originally part of the overlying Tripolitza Unit, which became tectonically independent owing to low tectonic competence (i.e., slate is readily deformed as opposed to the limestone of the Tripoliza Nappe). On Crete, the age of the Tyros Unit is thought to be Upper Triassic.

View of the Zakros Gorge looking East. 1: Tripolitza nappe, 2: Slope talus, 3: Tyros beds (dashed line indicates thrust plane)

3: Uppermost Violet Slates (Tyros beds/ Toplou beds), 2: Slope talus



Overview of the Zakros Gorge [Google Maps].

Tripoliza Flysch

The gorge of Zakros has deepened rapidly due to recent tectonic uplift and fluvial erosion. In the area of Kato Zakros, there is a syncline in which Tripolitza flysch overlies the Tripoliza limestone and crops out at sea level. The ruins of the Kato Zakros palace also lie on the flysch, which can be observed within the excavation compound just east of the palace ruins. However, the Tripolitza flysch is best examined at the north end of the Kato Zakros beach.

Tripolitza flysch consisting of shale, sandstone, limestone and conglomerate beds at the north end of Kato Zakros beach.

Sequence of sandstone beds and shale resulting from turbidity currents. 1: sandstone, 2: shale

1: Closeup of the sandstone, which is probably a greywacke, due to its content of different immature clasts and lithic components. The greywacke represents material deposited by a turbidity current.

2: Silty shale bed representing marine background sedimentation.

3: Coarse sand and conglomerate beds are deposited first by the onslaught of fresh turbidity currents. The size of the clasts ideally diminishes as the turbidity current subsides to create graded bedding.

See My Field Guide: “Tripoliza Flysch and Pindos Nappe at Chametoulo” for further details on the formation of flysch.

Recent coastal subsidence

Since Minoan times the coast has subsided by 1-3m causing lower lying parts of the palace foundations to be submerged in spring when the groundwater level is at its highest (Blackman 2005).

1: Foundations of the former Minoan Zarkos Palace displaying groundwater ingress. 2: Foundations supplied with surface water by pumps to create ponds for turtles and fish.

1: Foundations of the Minoan Palace at Zakros submerged, due to subsidence (construction approx. 1800-1500 BC).

Marine Terraces

The Kato Zakros area provides good examples of marine terraces commonly found at the east coast of Crete. The best view of the marine terraces is from the lower part of the Kato Zakros-Zakros road. Towards the North on the southern slope of Mount Traghostalos, the terraces can be seen up to a height of about 450 m above sea level. They extend into the bay of Kato Zakros - so this must have existed as a relief form prior to their formation. Well-developed terraces are located at 200-220 m, 170-180 m and 100-110 m above sea level. They are independent of the tripolitza limestone bedding and display recent karstic weathering. The width of the beach terraces ranges from little more than 10m to over 100m; the cliffs behind them are generally no more than 25m high. Locally, remains of surf notches and boreholes of Lithophaga [a genus of medium-sized bivalves of the blue mussel family] are visible. Marine sediments of lower Pliocene age have been found at the highest terraces. At that time, considerable subsidence took place in eastern Crete, whereby the earth's crust is thought to have undergone gradual subsidence. From the upper Pliocene onwards, uplift took place, with the onset of erosion, especially of the soft Pliocene coastal sediments. During Pleistocene, the uplift process was superimposed by cold-temporal eustatic sea-level lowering.

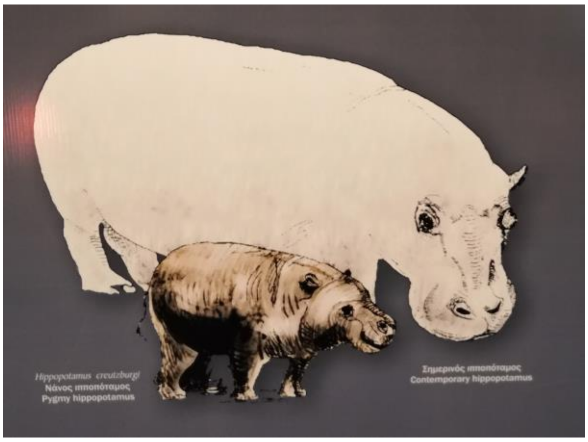
Marine terraces on the southern slope of Mount Traghostalos (Kato Zakros bay)

See My Field Guide: "No 1 Pleistocene to Recent Crustal Movement, Outcrops at Phalasarna, Paleochora and Aradhena Gorge" for further details on marine terraces.

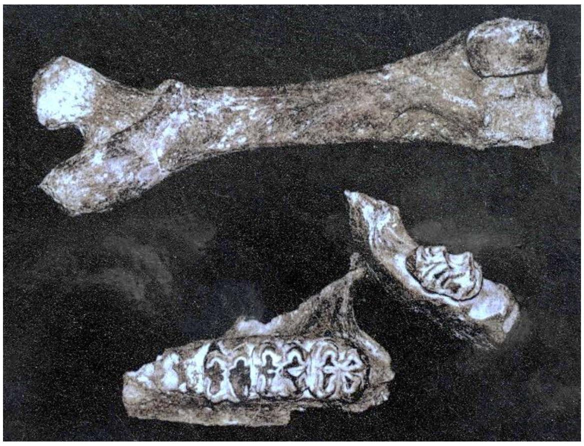
Tripoliza limestone

Mammal fossils

In the lowest marine terraces of the Zakros-Xerokambos area, hippopotamus and deer fossils have been found. The carcasses/bones of the dead mammals carried by coastline marine currents were deposited on the shores of marine terraces, where they were buried in the sand and fossilized.



Size of the pygmy *Hippopotamus creutzburgi* compared to the contemporary Hippopotamus



Bones of a pygmy hippopotamus (800.000 years old) found in a cave at one of the marine terraces in the Fagromouro area

The pygmy Hippopotamus *(Hippopotamus creutzburgi)* did not predominantly live in fresh water habitats, but lived rather like a pig, so that it was able to colonize damp areas in the mountains. Its disappearance is explained by changes in sea level and climatic conditions, which constricted its habitat to such an extent that the population fell below the critical extinction level.

Evolutionary wise, the different size changes in certain mammals particularly within the horizon called the *Kritimys Zone* are striking. Hippopotamus and elephant became smaller while rodents and insectivores developed larger forms than on the mainland. The absence of predators is thought to have had a great influence, as smaller sized individual would have been able to exist and multiply. In addition, the limitation of food sources on an island promotes a reduction in body size in larger animals. Regarding the rodents, larger forms are thought to have been less vulnerable to birds of prey. This led to a certain increase in body size. Corresponding evolutionary processes are known from other Mediterranean islands such as Sicily.

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Appendix