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The "Kato Zakros Marine Terraces" a geosite of international significance. Each terrace represents a period of tectonic uplift of Crete and furthermore the orogenesis model via the subduction of the African plate underneath the European plate

Sitia Geopark Conference 2016, Greece

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The meeting took place at the Multicenter of the Sitia Municipality, Eastern Crete Island, 26 February 2015. It was organized by the Sitia UNESCO world geopark. The title of the meeting was: "Engine for the local economy growth and the alternative tourism. Examples from other Greek & Global Geoparks".

The Conference gave the opportunity to the public to be informed about the new UNESCO global geoparks program, the geoparks in Greece and elsewhere, and their importance for the local communities. The organization and the benefits of these regions due to their inclusion in the world of UNESCO Geoparks network was thus in focus. On behalf of the Greek Geological Heritage Committee and ProGEO, the concept of geoconservation was promoted. It was stressed the attention to geosites outside the geoparks, the risk they incur, due to the fact that they are not registered, they don't have name, thus they don't exist. Representatives of the Geoparks in Greece and abroad (Geopark Troodos Cyprus, Vulkaneifel Germany), attended and presented their experience based on the functioning and organization of their Geoparks, and how these areas developed after integration into the European and Global Network.

Greece has now five geoparks:

- Lesvos island geopark (http://www.lesvosgeopark.gr) was one of the founder members of the European geoparks network in 2000, then named Lesvos Petrified Forest geopark. It was included in the newly formed global geoparks network in 2004 with the assistance of UNESCO. In 2012 it was extended and the whole of the Lesvos Island is now nominated as a geopark.
- Psiloritis geopark in Crete Island (http://www.psiloritisgeopark.gr/), included in the in the European geoparks network in 2001.
- Chelmos-Vouraikos geopark (http://www.fdchelmos.gr/en/), in Northern Peloponnese (2009).

- Vikos-Aoos geopark (http://www.vikosaoosge-opark.com/) in NW Greece (2010).
- Sitia geopark in Eastern Crete Island (http://www.sitia-geopark.gr/), was the last Greek geopark to be nominated in 2015.

All five geoparks are included in the new UNESCO Geoparks program, since 17.11.2015, during the 38th summit conference of UNESCO.

The meeting icluded a tour to the most important geosites of the Geopark. This offered a demonstration of key characteristics of the park, its natural-geological, and cultural environment, its archeology including witnesses of the prehistoric and historic times succession (Neolithic presence confirmed by the variety of artifacts, utensils and tools, Bronze Age, Minoan findings, Geometric period and onwards, Classical, Hellenistic, Roman, Arab, Byzantine, Turkish and Greek modern times with relevant civilizations).

A much known historic monastery with a significant collection of precious icons is included in the area (Moni Toplou 15th century), together with famous Minoan cities (Zakros) and world famous tourist destinations (Vai renowned palm forest, where the Cretan Date Palm, Phoenix theophrasti, is characterized as vulnerable in the IUCN Red List and it is protected by Greek legislation). The gastronomy in the small villages and the hospitality of the people is unique. Small information centers are scattered in the area.

The rocks are mainly of alpine age, limestone, marble and shale. There are three basic rock zones, the inferior one in the form of marble plates called Plattenkalk, the intermediate, comprising dark red phyllite and shale, called Phyllites-quartzites, and the superior, made up of limestone, dolomite, flysch, sandstone, clay and conglomerate rocks. The contacts between them are tectonic. Over a more limited area in the northern part of the geopark, there are more recent post-alpine rocks from the Miocene, Pliocene and Pleistocene.

There are numerous geosites with panels explaining the interest of each one. Some of the most important are:

- *Deinotherium Giganteum* site. This gigantic species lived on the island 8-9 million years ago. The Sitia *Deinotherium* is the largest animal that ever lived on the island and the rest of Greece, 4.5-5 meters tall and 6 meters long. Findings are kept in the Natural History Museum of Crete.
- Hippopotamus of Pleistocene age, 800.000 y.

The platy marbles of the Platenkalk series. An important Geosite of Sitia Geopark ("Plakoures").

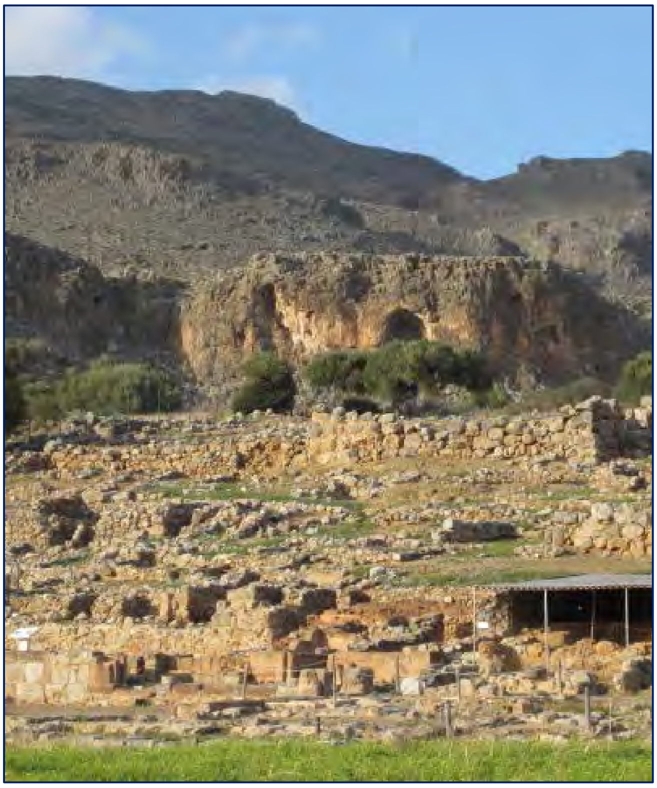
Two different parts of the lithospheric plates meet each other at this Geosite, the "Itanos upthust zone".

The magnificent "Kato Zakros Gorge" is a hallmark of the area. Numerous visitors pass this gorge annually via the E4 trail that follows its main stream.

- System of marine terraces due to uplift of the area caused by the subduction of African plate under the euroasiatic plate.
- Upthust zones between the alpine geotectonic zones.

The website of the geopark (http://www.sitia-geopark.gr/) give information about the environment, the endemic species, the history and culture, the geology, geosites as well as geotourism facilities and infrastructures, ways of access etc. Leaflets and maps with geotrails can be downloaded and a video is also available. Most is unfortunately only in Greek, but photos are quite speaking. Georoutes via Google earth are possible.

You can also perform a virtual tour within the overall Sitia Geopark area with the interactive web map application of the website. With the aid of this web map you can browse all the geosites and understand their characteristic, turn on and off the visibility of various layers on the map and understand the geology structure of the area. By clicking on the "view larger map" expression underneath you can open the map in an individual window and use it as a navigational tool on field via a mobile or tablet device.



The Minoan Era "Kato Zakros Palace" archaeological site, prevailing at the exit of the gorge, once met glorious thriving days.

Roebuck Plains, north-western Australia – a major Holocene carbonate mud deposit of international geoheritage significance

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Currently, the Roebuck Plains, a coastal area of international significance in north-western Australia is under threat from a number of activities such as mining, fracking, and groundwater abstraction and this article highlights to the Australian and international community the geoheritage significance of this area that is competing with economic values.

Roebuck Plains, a Holocene coastal plain some 15 km wide and 30 km long developed by the filling with carbonate mud of a large marine embayment, is located along the Canning Coast in north-western Australia (Figures 1 & 2). As a megascale supratidal to high-tidal flat that has been stranded by coastal progradation and underlain by a thick seaward-thickening wedge of tidal carbonate mud (Semeniuk 2008), it is a geological feature of international geoheritage significance. Roebuck Plains is vegetated by grasses and, to seawards, by samphires. Further seawards, it is bordered by a 200 m wide band of mangroves in the high- to mid-tidal level and then by extensive 2500 m wide low-tidal mud flats (Figure 3) both traversed by deep tidal creeks – these latter two seaward zones constitute Roebuck Bay. During the monsoon and for a short time into the ensuing dry season, because it is comprised of mud that perches rainwater, it is a megascale wetland. Roebuck Plains today, carries with it a distinctive stratigraphy, the complexities of its sedimentary evolution, a hydrological story, a variety of localised wetlands, diagenesis, and an archaeological history.

The Canning Coast, some 600 km long, mainly fronts the western margin of the Great Sandy Desert, and is the Quaternary coastal fringe of the Canning Basin (Semeniuk 2008; and Figure 1). Sedimentologically and compositionally, this coastal system is a complex of Holocene sedimentary environments occurring in tidal flat, beach, dune, dune barrier, tidal embayments, lagoons, bays, and open coasts, and involves carbonate sand sedimentation, carbonate mud sedimentation, and reworking of quartz-dominated Pleistocene desert dunes to form quartz-rich coastal sands. These sediments overlie or abut the Pleistocene desert dune deposits, rocky shores cut into Mesozoic sandstone (dominantly,

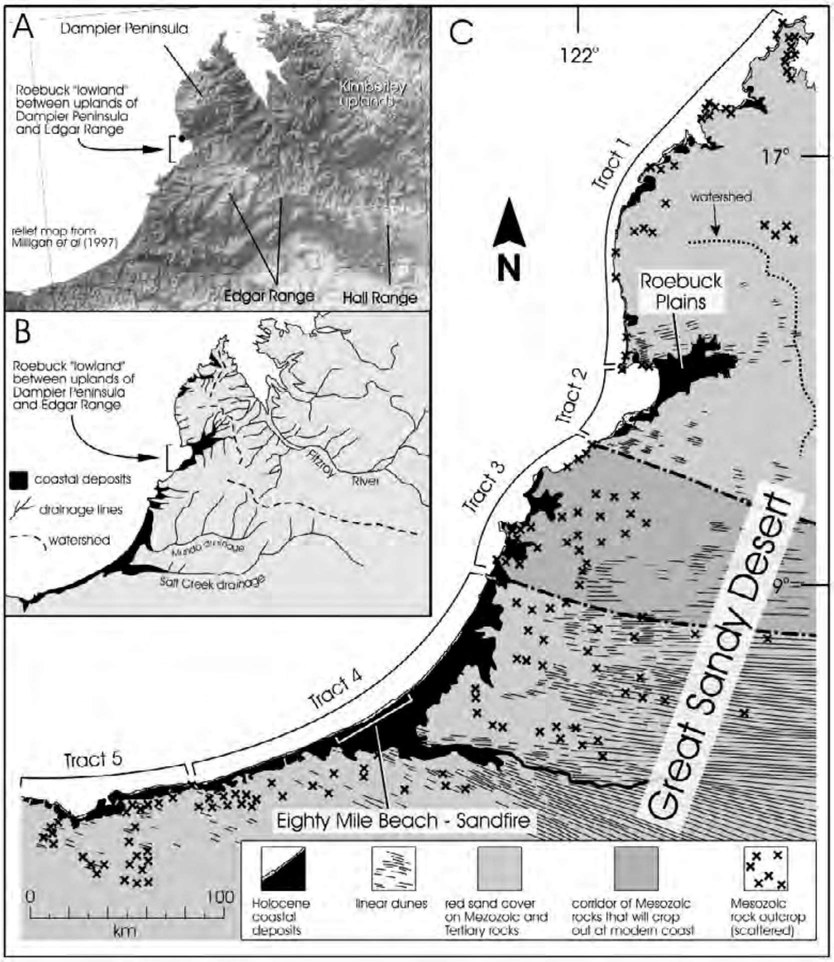

Figure 1: Regional framework for the Canning Coast in north-western Australia (modified from Semeniuk 2008). A. Relief map from Milligan et al. (1997) showing the physiography that underpins the form of the Canning Coast. B. Major and minor drainage lines and uplands that control the form of the Canning Coast and the adjoining drainage of the Fitzroy River that forms King Sound. C. The five coastal tracts and the distribution of Holocene coastal sediments within the regional framework of the Coast.

Broome Sandstone), or Quaternary limestone ridge barriers. One of the characteristic features of this Coast is that, unlike the adjoining terrigenous-dominated systems to the southwest (the Pilbara Coast) and northeast (King Sound and the Kimberley Coast), sedimentologically, there is negligible fluvial contribution (Semeniuk 1993) and, as a result, coastal sedimentation, where fine-grained, is composed of marine-derived carbonate mud. The Canning Coast has been subdivided into four tracts by Semeniuk (2008) and Roebuck Plains and its tidally-inundated seaward margin, Roebuck Bay, comprise the majority of Tract 2 (Figure 1).

The Canning Coast is macrotidal, but most of the coast can be viewed as mixed wave- and tide-influenced. Tides are semi-diurnal, increasing in range from south to north, with a spring tidal range of ~ 6 m in southern parts of the Coast and ~ 8 m in northern parts (Semeniuk 2008). At Broome itself, which immediately adjoins Roebuck Bay, maximum tidal range is 10.5 m. The coastal sediments are distinctly related to tidal levels, hence, regionally, the individual, environmentally-distinct, tidally-related stratigraphic units along the Canning Coast are of reasonably consistent composition and thickness to be readily recognised formally as Formations (Semeniuk 2008). In addition, as the various sediment/stratigraphic units are distinctly related to tidal levels, they are useful as palaeo-environmental indicators. The identification of these Formations, and their assignment to standard coastal sequences, has helped to unravel Holocene regional coastal history and palaeogeography, and has assisted in the interpretation of Holocene Indigenous history along the shores of the Roebuck Embayment.

Formerly, Roebuck Plains was lodged in a tropical subhumid environment but with Earth-axis Precession and the shift of the Tropic of Capricorn over the past few millennia (Semeniuk 2012), today it resides in a tropical semi-arid climate with a southern hemisphere summer monsoon. In terms of sedimentary evolution, following the post-glacial transgression some 7500 years BP, the geographic area of Roebuck Plains originally was a large blue-water embayment formed by marine flooding of the lowlands occurring along a short-creek valley axis. We call this large early Holocene coastal bay deeply embayed into the hinterland (uplands) the Roebuck 'Blue Water' Embayment – it was open to the Indian Ocean and, before tidal mud transport took place, it was devoid of marine muddy sediment. The shores of this Embayment comprised either cliffs cut into the Pleistocene red sand of the desert linear dune uplands (referred to the Mowanjum Sand of Semeniuk 1980, 2008) or fingers of these linear dunes projecting into the embayment margin and, locally, Mesozoic sandstone (the Broome Sandstone) as outcrops and subcrops.

The Roebuck 'Blue Water' Embayment at the height of the post-glacial transgression was largely tidal and initially floored by low-tidal-flat sand. At this time, sea level was 2.5 m higher than present (Semeniuk 2008). With progressive falling of sea level, and the filling of the embayment by carbonate mud derived from marine sources, the embayment shoaled and tidal flat sediments prograded to form a coastal plain. By 5000 years BP, the Plain had accreted seawards by 12 km; by 2500 yrs BP the Plain had prograded another 18 km. At all

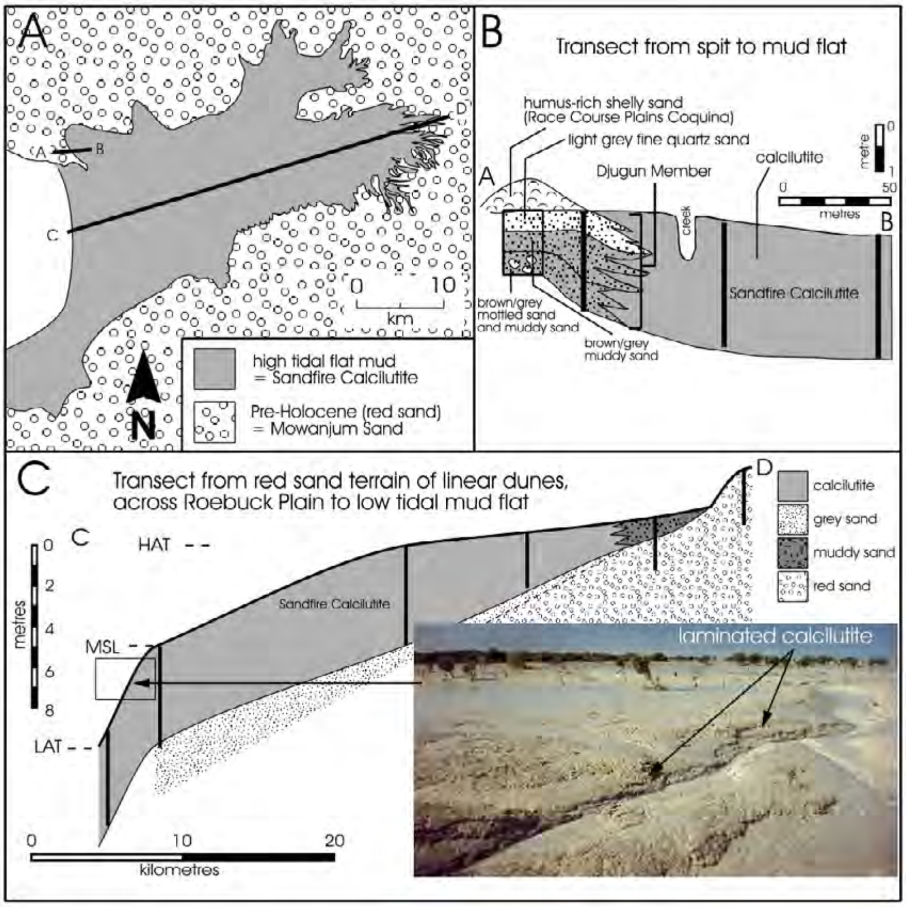

Figure 2: Stratigraphic profiles of Roebuck Plains showing relationship of wedge of carbonate mud (Sandfire Calcilutite) to the red sand (Mowanjum Sand), and the occurrence of Djugun Member (of the Sandfire Calcilutite) between Sandfire Calcilutite and Mowanjum Sand (modified from Semeniuk 2008).

times during its accretionary history, the sedimentary system was comprised of three-fold tide-related facies: 1) low-tidal sand flats that eventually developed with change in coastal erosional processes into low-tidal mud flats; 2) a mangrove zone between MSL and high-water spring tide, with mangroves inhabiting a carbonate mud substrate; and 3) a supratidal carbonate mud plain developed by shoaling of tidal-flat mud and by stranding of tidal deposits by a falling sea level. Today, under conditions of coastal erosion, the seaward parts of Roebuck Plains (i.e., Roebuck Bay) are extensive, wide mud tidal flats. The main stratigraphy under Roebuck Plains, with mud up to 10 m thick, consists of a shoaling sequence of low tidal flat sand or mud overlain by mid-tidal shelly mud overlain by mangrove-facies composed of bioturbated and root-structured grey (anoxic) mud and capped by high-tidal to supratidal oxidised mud. Today, bordering the mud-filled Roebuck embayment are the (formerly cliffed) red sands of the Pleistocene desert-dune uplands, standing some 5-8 m above the level of the Plain, locally with fingers of the linear dunes projecting, to a limited extent, into the embayment and, in subcrop, the Broome Sandstone. These upland materials of Pleistocene sand, and the subcrops of Broome Sandstone function as aquifers storing freshwater, and by discharging groundwater to the adjoining hydraulically lower levels will interact with the prism of carbonate mud (Figure 4).

The case for the international geoheritage significance of Roebuck Plains and its adjoining seaward unit, viz., the tidal flats of Roebuck Bay, is made on the bases that it represents the largest and thickest tidal carbonate deposit in the world, the complexities of its sedimentary evolution, the hydrologic relationships between uplands and the Plain leading to the development of three types of freshwater wetlands, a unique setting for tropical humid carbonate diagenesis, its archaeological history following the unfolding Holocene history of palaeogeography and palaeo-environments, and the function of the Roebuck Plains and Roebuck Bay system (with the diversity of tidal-flat benthos therein) as an internationally-important and recognised staging ground for trans-equatorial waterbirds.

The Roebuck Plains and Roebuck Bay mud system constitute the largest and thickest tidal carbonate deposit in the world. At the national scale, in Australia, carbonate mud as a tidal coastal deposit is not prevalent or is only thinly developed in the rest of Western Australia (which itself is dominated by estuaries, beaches and dunes, ria coasts, archipelago, and limestone barrier coasts; Semeniuk 1980, 1981; Searle & Semeniuk 1985; Semeniuk & Semeniuk 1990; Semeniuk 1993, 1996, 2000, 2011; Brocx & Semeniuk 2011; Semeniuk & Brocx 2011; Semeniuk et al. 2011). Comparatively, the other largest carbonate deposits in Western Australia are in the Eighty Mile Beach to Sandfire region further south along the Canning Coast (Semeniuk 2008) and at Shark Bay (Logan 1970, 1974).

In the Eighty Mile Beach to Sandfire region, with the post-glacial transgression and sea level reaching a level of 2 m above present, carbonate mud began filling a deep funnel-shaped riverine valley cut into Mesozoic sandstone (Semeniuk 2008). From 7500 years BP to 3500 years BP, carbonate mud progressively filled the

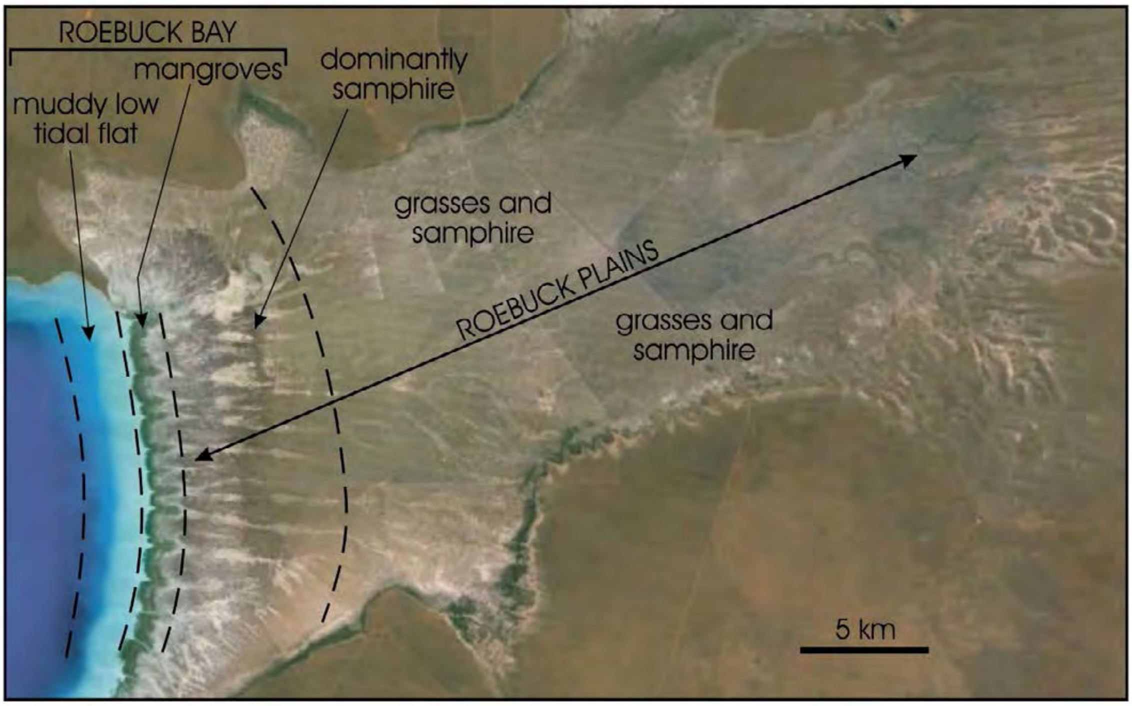

Figure 3: The location of Roebuck Bay and Roebuck Plains and their vegetation. Image from Google™Earth

funnel-shaped valley tract, initially in its relatively narrow headwaters in its eastern part, but progressively filling the wider parts as progradation proceeded seawards. However, facing the open Indian Ocean (in contrast to the relative protected situation of Roebuck Bay and the former embayment in its Roebuck 'Blue Water' Embayment phase), this sedimentary complex was subject to oceanic waves. As a result, as progradation preceded, mud-flat deposition was interrupted periodically by development of shore-parallel barriers and cheniers (Figures 25, 26 & 27 of Semeniuk 2008). The present coast is one of a large dune barrier (Eighty Mile Beach) fronted by a beach and sandy tidal flats with stranded (now-supratidal) mud flats, cheniers, and barriers to leeward. As such, its stratigraphic architecture, its detailed stratigraphy, and the present sedimentary facies along the open coast are unlike the system of Roebuck Bay and the stranded supratidal Roebuck Plains.

At Shark Bay, the carbonate deposits are mainly locked into shallow-water subtidal seagrass banks as carbonate sand and carbonate muddy sand and, in deeper water, carbonate mud deposits. There are, however, carbonate muds on the tidal flats. In the microtidal setting of Shark Bay (~ 0.5 m tidal range), the tidal deposits are thin, usually < 1 m thick, and lithologically reflect a setting in an arid climate with its attendant hypersalinity and diagenesis i.e., crusts, intraclasts, flat-pebble breccias, stromatolites, and scattered to network-disruptive gypsum crystals (Logan 1974; Logan et al. 1974). Thus, the Shark Bay tidal mud deposits are wholly incomparable in terms of thickness, lithology, and diagenetically generated lithologies to the carbonate muds of Roebuck Plains and Roebuck Bay.

The eastern and northern coasts of Australia are river- and estuary-dominated and consequently do not have extensive carbonate depositional environments.

From the above information, it is clear that, nationally, the carbonate mud system of Roebuck Plains and Roebuck Bay, in terms of thickness, lateral development, and lithology, is unique.

From a comparison of carbonate tidal flats worldwide, the Roebuck Plains and Roebuck Bay mud system is concluded to be globally unique also. Globally, tidal carbonate mud deposits occur in The Bahamas, Florida Bay, and the Abu Dhabi Trucial Coast tidal flats of the western Persian Gulf. All are microtidal, with a maximum tidal range of 2 m and usually < 1m. The tidal flats of The Bahamas and Florida Bay are typified by Andros Island (Shinn et al. 1969; Ginsburg & Hardie 1975; Shinn 1983) and Crane Key (Enos & Perkins 1979), respectively. The tidal flat at Andros Island is 20-km wide and up to 50 km along its length and at Crane Key is narrower, only ~ 150-500 m wide; both are set in a humid climate. These tidal flats are characterised by ponds and marshes that contain well-developed algal mat communities. Though their tidal flats are dominated by carbonate mud, the characteristic macroscopic feature is the abundance of shore-normal tidal drainage channels with their distinctive stratigraphic signature of channel incisions and levee deposits; at the smaller scales the imprint in the tidal zone is of root-structuring, storm deposits (sheets of sand and intraclasts), and faunal burrows. These mud deposits, though laterally extensive, are not comparable to the Roebuck Plains and

Roebuck Bay system in stratigraphic architecture, stratigraphy, lithology, or diagenesis. The stratigraphy of the Abu Dhabi tidal flats, though laterally extensive and carbonate-mud dominated, is a thin sheet of mud that shows sedimentary and diagenetic imprints of an arid climate, viz., algal mats, gypsum, gypsum-disruption fabrics, anhydrite development after gypsum, and desiccation (Kendall & Skipwith 1968, 1969a, 1969b; Kendall et al. 2002). Again, the Abu Dhabi tidal flats are wholly incomparable in terms of stratigraphy, thickness, lithologic suites, and diagenesis to the deposits of Roebuck Plains and Roebuck Bay.

Thus, in the above context of tidal flat stratigraphy, size and thickness, the carbonate mud deposit of Roebuck Plains and Roebuck Bay, in comparison to those of The Bahamas, Florida Bay, and Abu Dhabi, is globally unique.

Other areas that have large tidal ranges similar to the Roebuck system include the tidal flats of Mont St Michel, The Wash, the Colorado River Delta, the tide-dominated delta of the Fitzroy River in King Sound, the Bay of Fundy, and some of the macrotidal deltas in the Malaysian Archipelago and Papua New Guinea, but these are all non-carbonate siliciclastic systems (Klein 1963; Evans 1965; Thompson 1968; Ginsburg 1975; Semeniuk 2005; Semeniuk & Brocx 2011).

The thick deposits of tidal carbonate mud of Roebuck Plains and Roebuck Bay are the result of the macrotidal setting, lack of fluvial contribution, and (in a regional context for the Canning Coast), a change in climate during the Holocene from Tropical subhumid to Tropical semi-arid. From this perspective, this large carbonate deposit of Roebuck Plains and Roebuck Bay is globally only one of its kind. Also, from the perspective that the stratigraphy under the Roebuck Plains and Roebuck Bay records a specific sequence of lithology (termed formally by Semeniuk 2008 as the Lagrange Calcilutite Member for the root-structured, weakly shelly, carbonate mud, accumulated and diagenetically altered under mangrove cover, and the Crab Creek Calcilutite Member for the bioturbated/laminated, shelly carbonate mud accumulated in the mid- to low-tidal zone), the carbonate mud of Roebuck Plains and Roebuck Bay is globally also only one of its kind. The Roebuck Bay and Roebuck Plains stratigraphic system records complexities of sedimentary evolution in a tropical climate that has experienced a change in climate towards aridity, of benthic-rich and diverse tidal mud accumulation, of mangrove-influenced carbonate mud accumulation, of a shoaling mud stratigraphy that accreted to the level of a freshwater-influenced supratidal plain with its diagenetic products and its marsh- and grass-covered surface, and of a sea level falling from + 2 m to the present level.

Aside from the fact that during the monsoon and for a short time into the dry season, the entire length and breadth of the Roebuck Plains is a megascale wetland (and, in fact, one of the largest in Western Australia), there are other wetlands developed in localised and hydrologic-specific environments near the margin of plain and are significant from a geoheritage viewpoint. Wetlands occur along the interface of the red sand upland and mud plain as Melaleuca-fringed slopes, on the mud plain but near the red sand / mud plain interface as Sesbania-fringed basins, and as Melaleuca- and samphire-fringed solution-excavated basins and channels on the Plain adjoining the red sand / mud plain interface (Figure 4, and V & C Semeniuk Research Group 2011, 2013; Mathew et al. 2011). These wetlands have formed because of hydrologic interactions between the carbonate mud wedge filling the Roebuck embayment and the freshwater residing in the aquifer under the uplands. Freshwater that was recharged by rainfall during the monsoon is stored in the red sand dunes and discharges towards the hydraulically lower Plain where it meets an impediment of a mud (Mathew et al. 2011). Freshwater then discharges either above the surface of the mud wedge to form wetland slopes (Melaleuca-fringed wetland slopes; A in Figure 4) along nearly the entire interface between the red sand uplands and the mud plain lowlands, or under the wedge of mud to emerge at upwelling sites (locally known as ‘soaks’) on the plain, a short distance into the mud plain (Sesbania-fringed basins; B in Figure 4). The third type of wetland results from freshwater discharging along the interface between the red sand terrain and the mud plain but (diagenetically) dissolving the carbonate mud on the surface or shallow subsurface to form solution basins and channel-ways (C in Figure 4). These are vegetated to form Melaleuca- and samphire-fringed basins and channels.

The diagenesis of the carbonate mud under Roebuck Plains is manifold in a climatically and stratigraphically distinct environment. It is driven by the resident groundwater under the Plain, the seaward-discharging fresh groundwater from the red sand dunes, and by rainwater on and under the Plain. Groundwater under the Plain generally is 1-2 m deep during the dry season, depending on location. Diagenesis involves solution of the carbonate mud in the near-surface and on the surface by groundwater seepage from the dunes to form solution-excavated depressions exposing the watertable and hence forming wetlands as described above (Mathew et al. 2011), solution of the carbonate mud in the subsurface (especially along the hydraulically active buried contact of red sand and carbonate mud) to form conduits for the freshwater upwelling on the plain (V & C Semeniuk Research Group 2011, 2013), induration of the upper ~ 50 cm of the carbonate mud profile by microsolution and reprecipitation, root-structuring by grasses, samphires, and shrubs, burrow-structuring by invertebrates, mud-cracking and ped formation by dry-season desiccation of mud saturated with water from the monsoon, and infiltration of mud by rainwater into mud cracks, along ped boundaries, and down root holes and invertebrate burrows.

The tidal flats of Roebuck Bay are an internationally-important staging and feeding ground for trans-equatorial water birds and are inscribed as a major Ramsar site (Department of Environment & Conservation 2009). It has one of the most diverse tidal flat fauna in the world (Department of Environment & Conservation 2009) and, as such, a diverse shelly lithology. The shores of Roebuck 'Blue Water' Embayment during the Holocene were important sites for occupation by Indigenous people who accessed the locally shallow freshwater groundwater and soaks, harvested shell life and fish from the tidal flats and waters, and were involved in tool-making, story telling, and other social activities. They left a rich archaeological record as middens of shells, stone tools, and debitage on the high ground bordering the mud plain. These middens are intimately intercalated and/ or incorporated into the Holocene stratigraphic sequences, and form part of the stratigraphic story of the region.

The case for the international geoheritage significance is made on the bases of

- its being the largest and thickest tidal carbonate deposit in the world,
- the complexities of its sedimentary evolution, its distinctive stratigraphy,
- the hydrologic relationships between uplands and the Plain leading to the development of three types of freshwater wetlands,
- a climatically and stratigraphically distinct setting for carbonate diagenesis,
- the function of the Roebuck Plains and Roebuck Bay system with the diversity of tidal flat benthos as an internationally important and recognised staging ground for trans-equatorial water birds, and
- its archaeology.

References

Brocx M & Semeniuk V 2011. The global geoheritage significance of the Kimberley Coast, Western Australia. Journal of the Royal Society of Western Australia 94: 57-88.

Department of Environment & Conservation 2009. Roebuck Bay Ramsar Information Sheet (RIS) - 2006-2008 version. Department of Environment and Conservation 17 Dick Perry Avenue, Technology Park, Kensington WA 6983, Australia.

Evans G 1965. Intertidal flat sediments and their environments of deposition in the Wash. Quarterly Journal of the Geological Society of London 121: 209-241.

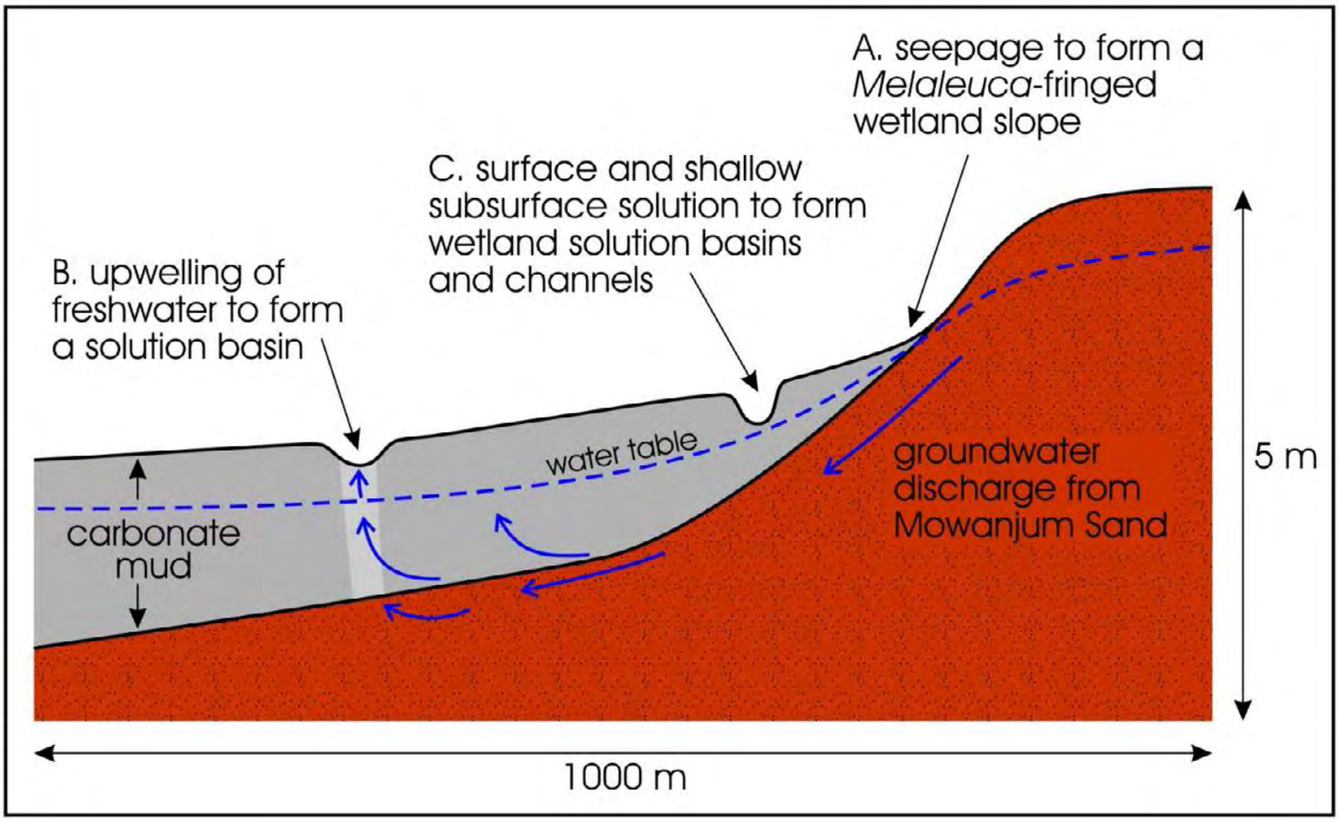

Figure 4: Profile showing stratigraphic relationship of carbonate mud to the red sand of the Mowanjum Sand, the water table, and mechanisms of how the wetlands form on or near the red sand/ carbonate mud interface.

Ginsburg R N (ed) 1975. Tidal Deposits: A Casebook of Recent Examples and Fossil Counterparts, Springer-Verlag, New York..
Ginsburg R N & Hardie L A 1975. Tidal and storm deposits, northwestern Andros Island, Bahamas. In: R N Ginsburg (ed) Tidal deposits – a casebook of Recent examples and fossil counterparts. Springer-Verlag, Berlin. pp 201-208.
Kendall C G St. C & Skipwith Sir P A D'E 1968. Recent algal mats of a Persian Gulf lagoon. Journal of Sedimentary Petrology 38: 1040-1058.
Kendall C G St. C & Skipwith Sir P A D'E 1969a.. Geomorphology of a Recent shallow-water carbonate province: Khor al Bazam, Trucial Coast, South-West Persian Gulf. Geological Society of America Bulletin 80: 865– 891.
Kendall G St. C & Skipwith Sir P A D'E 1969b. Holocene shallow water carbonate and evaporite sediments of Khor al Bazam, Abu Dhabi, southwest Persian Gulf. American Association of Petroleum Geologists Bulletin 53: 841-869.
Kendall, C G St.C, Alsharhan A S & Cohen A 2002. The Holocene tidal flat complex of the Arabian Gulf Coast of Abu Dhabi. In: H J Barth & B B Boer (eds.), Sabkha Ecosystems. Kluwer Academic Publishers, Dordrecht, pp. 21– 35.
Klein G D 1963. Bay of Fundy intertidal zone sediments. Journal of Sedimentary Petrology 33: 844–854.
Logan B W (ed) 1970. Carbonate Sedimentation and Environments Shark Bay Western Australia. American Association of Petroleum Geologists Memoir 13.
Logan B W (ed) 1974. Evolution and Diagenesis of Quaternary Carbonate Sequences, Shark Bay, Western Australia. American Association of Petroleum Geologists Memoir 22. Tulsa, Oklahoma.
Logan B W 1974. Inventory of diagenesis in Holocene-Recent carbonate sediments, Shark Bay, Western Australia. In: B W Logan (ed), Evolution and diagenesis of Quaternary carbonate sequences, Shark Bay, Western Australia. American Association of Petroleum Geologists Memoir 22: 195-249.
Logan B W, Hoffman P & Gebelein C 1974. Algal mats, cryptalgal fabrics and structures, Shark Bay, Western Australia. In: B W Logan (ed), Evolution and diagenesis of Quaternary carbonate sequences, Shark Bay, Western Australia. American Association of Petroleum Geologists Memoir 22: 140-194.
Mathews D, Semeniuk V & Semeniuk C A 2011. Freshwater seepage along the coast of the western Dampier Peninsula, Kimberley region, Western Australia. Journal of the Royal Society of Western Australia 94: 207-212.
Milligan P R, Mackey T E, Morse M P & Bernardel G 1997. Elevation image of Australia with northwest illumination. Australian Geological Survey Organisation. Department of primary Industries and Energy, Canberra.
Searle D J & Semeniuk V 1985. The natural sectors of the Rottnest Shelf Coast adjoining the Swan Coastal Plain. Journal of the Royal Society of Western Australia 67: 116-136.
Semeniuk C A & Semeniuk V 1990. The coastal landforms and peripheral wetlands of the Peel-Harvey Estuarine System. Journal of the Royal Society of Western Australia 73: 9-21.
Semeniuk C A & Semeniuk V 1995. A geomorphic approach to global wetland classification for inland wetlands. Vegetatio 118: 103-124.
Semeniuk V 1980. Quaternary stratigraphy of the tidal flats, King Sound, Western Australia. Journal of the Royal Society of Western Australia 63: 65–78.
Semeniuk V 1981. Sedimentology and the stratigraphic sequence of a tropical tidal flat, north-western Australia. Sedimentary Geology 29: 195-221.
Semeniuk V 1993. The mangrove systems of Western Australia: 1993 Presidential Address. Journal of the Royal Society of Western Australia 76: 99-122.
Semeniuk V 1996. Coastal forms and Quaternary processes along the arid Pilbara coast of northwestern Australia. Palaeogeography Palaeoclimatology Palaeoecology 123: 49-84.
Semeniuk V 2000. Sedimentology and Holocene stratigraphy of Leschenault Inlet. Journal of the Royal Society of Western Australia Special Issue on the Leschenault Inlet Estuary 83: 255-274.
Semeniuk V 2005 Tidal flats. In: Schwartz M.L (ed) Encyclopaedia of coastal science. Springer.
Semeniuk V 2008. Sedimentation, stratigraphy, biostratigraphy, and Holocene history of the Canning Coast, north-western Australia. Journal of the Royal Society of Western Australia 91: 53-148.
Semeniuk V 2011. Stratigraphic patterns in coastal sediment sequences in the Kimberley region, Western Australia: products of coastal form, oceanographic setting, sedimentary suites, sediment supply, and biogenesis. Journal of the Royal Society of Western Australia 94: 133-150.
Semeniuk V 2012. Predicted response of coastal wetlands to climate changes – a Western Australian model. Hydrobiologia [doi: 10.1007/s10750-012-1159-0], Vol. 708 Issue 1 May 2013. p. 23-43.
Semeniuk V & Brocx M 2011. King Sound and the tide-dominated delta of the Fitzroy River: their geoheritage values. Journal of the Royal Society of Western Australia 94: 151-160.
Semeniuk V, Semeniuk C A, Tauss C, Unno J & Brocx M 2011. Walpole and Nornalup Inlets: landforms, stratigraphy, evolution, hydrology, water quality, biota, and geoheritage. Western Australian Museum, Perth (Monograph). 584 p. ISBN 978-1-920843-37-3.
Shinn E A 1983. Tidal flat environment. In: P A Scholle, B G Bebout & C H Moore (eds) Carbonate depositional environments. American Association of Petroleum Geologists Memoir 33, 171-210.
Shinn E A, Lloyd R M, & Ginsburg R N 1969. Anatomy of a modern tidal flat, Andros Island, Bahamas. Journal of Sedimentary Petrology 39: 1202-1228.
Thompson R W 1968. Tidal flat sedimentation on the Colorado River Delta, Northwestern Gulf of California. Geological Society America Memoir 107, 133pp.
V & C Semeniuk Research Group 2011. Wetlands of the Nyamba Buru Yawuru Broome regional area: the coastal wetlands, stratigraphy and hydrology, natural maintenance, environmental and geoheritage significance, and recommendations for management. Report to Nyamba Buru Yawuru Ltd, July 2011.
V & C Semeniuk Research Group 2013. Wetlands of the Nyamba Buru Yawuru Broome regional area: the coastal wetlands, stratigraphy and hydrology, natural maintenance, environmental and geoheritage significance, and recommendations for management. Report to Nyamba Buru Yawuru Ltd, June 2013.

The Framework List of geosites in Turkey

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The idea of protecting natural assets that have visual and scientific value can be dated back to 350 years ago, with the efforts made regarding Baumann Cave and Giant Causeway (e.g. Burek and Prosser, 2008; Doughty, 2008; Erikstad, 2008). However, it seems that these first experiences did not make a deep impact on geoconservation until establishment of ProGEO (European Association for the Conservation of Geological Heritage) in 1995. Starting from 1970s, geoconservation problems were expressed frequently in Turkey, but they stayed as complaints from some earth scientists for years (e.g. Ketin,1970; Arpat,1976; Arpat and Güner,1976; Öngür, 1976; Özdemir et al., 1986). The question has been how and by whom the great number and many types of geological heritage could be protected. Another important discussion has been whether to open these geosites to touristic visits, as it was known that many significant sites were disturbed by such activities. Overall, the Turkish Association for Conservation of the Geological Heritage (JEMiRKO) has carried out a very high effort since its founding (2000) and today, there is a voluminous geological heritage list for Turkey by the contributions of many colleagues.

The increasing pop ularity o f geoher itage, raises t he problem that different groups, volunteers, geoheritagelowers, ecologists, tourist-guides and even local people are describe geoheritage and geosites differently. One of the crucial problems for geosites, geological heritage, and geological conservation is attribution of different meanings to these terms. JEMIRKO tries to be faithful to the original definitions created by ProGEO in order to avoid reverting the natural values; the suggestion and acceptance of geosites (www.progeo.ngo).

The JEMiRKO has Advisory Committees, each consisting of three persons for each category. According to the method that was adopted during the General Assembly Meeting in 2002 and approved at the meeting of ProGEO Southeastern Europe Countries Working Group (WG1); the geosite suggestions made by geoscientists using the application form, are examined by the relevant Advisory Committee. Suggestions that are found suitable are submitted to the JEMiRKO's General Assembly were they are discussed and eventually added to the geosite list. Suggestions that are not approved by the committee are not discussed again. Currently, there are a total of 815 geosites, some of them are in the process of approval (490), in the JEMiRKO's inventory. The names and locations of these geosites are not announced in order to protect them from plunder by collectors. For further geological interpretations and comparison a Framework List as stated by ProGeo (1998) is important.

A framework list is an attempt to associate the geosites that are under the same group or category of a country list according to their common geological features (Brilha et al., 2005). A large number of geosites can be classified under the same framework. It also creates an opportunity to compare geosites internationally. Despite the fact that the need for a framework list for Turkey has been underlined before (e.g. Kazancı and Şaroğlu, 2009), it has not been possible to publish a written document until today. Kazancı et. al., (2015) presented a Geosite Framework List for Turkey (Table 1). The list containes 10 categories, and resembles the "Southeastern Europe Countries Framework List" (Theodossiou-Drandaki et al., 2004). During its preparation the Balkan list was taken into consideration, but it was necessary to add a number of new titles to facilitate Turkish geodiversity, such as "extensional volcanism in the Plio-Quaternary", "transform fault volcanism", "local natural building stones", etc. (Table 1).

The aim of the framework list is to act collaboratively with the global geoscientific community and to increase the impact of research on these sites. Publications that refer the framework list will be more widely understood. One of the results of the studies on geosites, geological heritage, and geoparks show that all natural occurrences represent geodiversity. Relevant topics and disciplines are not in competition, but support each other. Another result from the geosite and framework list studies is that the urgent need for geological conservation in our country has unfortunately increased to a dramatic level (Kazancı et al., 2005; 2012). The interest of local administrations are increasing gradually. Geoparks and geotourism could serve geoconservation if people are well informed. The responsibility for this subject belongs to geoscientists.

References

Arpat, E. 1976. Insan Ayagi iz fosilleri; yitirilen bir dogal anit. Yeryuvari ve Insan, 1/4, 65-66.

Arpat, E., Güner, Y. 1976. Agri buz magarasi; ender bir doğal anit. Yeryuvari ve Insan, 1/1, 95-96.

Burek, C.V., Prosser, C.D. 2008. The History of Geoconservation. Geological Society, Spec. Pub. 300, London, 312 s.

Doughty, P. 2008. How things began: the origin of geological conservation. In: The History of Geoconservation (Ed. Burek ve Prosser), Geol. Soc. Spec. Pub. 300, London, s. 7-16.

Erikstad, L. 2008. History of geoconservation in Europe. ‹ç: The History of Geoconservation (Ed. C.V. Burek ve C.D. Prosser), Geol. Soc. Spec. Pub. 300, London, s. 249-256.

Kazanci, N. 2010. Jeolojik Koruma; Kavram ve Terimler. Jeolojik Mirasi Koruma Dernegi yayini, Ankara, 60 s.

Kazanci, N., Saroglu, F. 2009. Türkiye Jeositleri Cati Listesi. 62. Türkiye Jeoloji Kurultayi (13-17 Nisan 2009) Bildiri Özleri Kitabi-I, Jeoloji Mühendisleri Odasi, Ankara, s. 266-267.

Kazanci, N., Saroglu, F., Kirman, E., Uysal, F. 2005, Basic threats on geosites and geoheritages in Turkey. Proceedings of Second Conference on Geoheritage of Serbia, June 2004 Belgrade, pp. 149-153, Belgrade, Serbia-Montenegro.

Kazanci, N., Saroglu, F., Dogan, A., Mülazimoglu, N. 2012. Geoconservation and geoheritage in Turkey. ‹ç: Geoheritage in Europe and its Conservation (Ed. W.A.P. Wimbledon ve S. Smith-Meyer), ProGeo Spec. Pub, Oslo, Norway, s. 366-377.

Kazanci, N., Saroglu, F., Suludere, Y., 2015. Geological heritage and framework list of the geosites in Turkey. Bull. Min. Res. Exp., 151, 259-268

Ketin, I. 1970. Turkiye'de önemli jeolojik aflormanlarin korunmasi. Türkiye Jeoloji Kurumu Bülteni XI/2, s. 90-93.

Öngür, T. 1976, Dogal anitlarin korunmasinda yasal dayanaklar. Yeryuvari ve Insan, 1/4, 17-23.

Özdemir, Ü., Göncüoglu, M.C., Tütüncü, G., Tanca, N., Tümer, A. 1986. Dogal Anitlar. Ege Univ. Journal of Science Faculty, Ser. B, 8, 221-230.

ProGeo Group. 1998. A first attemt at a geosites framework for Europe -an IUGS initiative to support recognition of World heritage and European geodiversity. Geologica Balcanica 28, 5-32.

Theodossiou-Drandaki, I, R., Nakov,P., Wimbledon, W.A.P., Serjani, A., Neziraj, A., Hallaci, H., Sijaric, G., Begovic, P., Todorov, T., Tchoumatchenco, Pl., Diakantoni, A., Fassoulas, Ch., Kazanci, N., Saroglu, F., Dogan, A., Dimitrijevic, M., Gavrilovic D., Krstic, B., Mijovic, D. 2004. IUGS Geosites project progress - a first attempt at a common framework list for south eastern European countries. In: M. Parkes, Ed., Natural and Cultural Landscapes- the Geological foundation. Proceedings of a Conference 9-11 September 2002, Dublin Castle, Ireland, Royal Irish Academy, Dublin, p. 81-90.

Table 1. The proposed "Geosite Framework List for Turkey"

Group a) STRATIGRAPHIC **a1**) *Quaternary* Marine coastal deposits (ooids, beachrocks, terraces, sand bars) Pleistocene Caliches and calcretes **a2**) *Phanerozoic* Late Neogene (Pliocene) marine deposits Neogene evaporite basins Parathetis successions Marine and continental Miocene molasse Complete marine cycles of Neogene Tertiary mammalian beds Extensive transgressions in Late Tertiary Palaeogene basins Paleogene bioherms Reference stratigraphic sections of Palaeogene stages Sedimentary and biological characteristics of time-boundaries Late Cretaceous-Palaeocene carbonates Late Cretaceous reefs Mesozoic carbonate platform Mesozoic platform deposits of Neothetis Jurassic-Cretaceous deep marine facies Ammonitico Rosso facies Triassic-Jurassic carbonate successions Late Triassic rift volcanisms related to the opening of Neothetis Ocean Rift deposits related to the opening of Neothetis Ocean Mesozoic Flysches Hersinian molasses Marine and continental deposits of Carboniferous Lower Palaeozoic succession of northern Gondwana Cambrian sedimentary sequence **a3**) *Proterozoic* Precambrian rocks	**Group b) PALAEOENVIRONMENTAL** Trace fossils Paleokarsts Foot prints on volcanites Mammalia beds with hominoid and handcrafts Fish and leaf fossils Neogene paleosols Neogene siliceous trees Miocene bivalves Large Tertiary foraminiferas Incised valleys Cretaceous ammonites Devonian fishes Euxinic environments of Early Silurian Ordovician and Silurian Graptolites **Group c) VOLCANIC, METAMORPHIC AND SEDIMENTARY PETROLOGY, TEXTURES AND STRUCTURES, EVENTS AND PROVINCES** Collision volcanisms of Quaternary Extension volcanisms of Plio-Quaternary Volcanic landforms (Calderas, Maars,Tuff rings) Bazalt lakes and columnar basalts Pyroclastic flows and ignimbrites Neogene rift volcanisms Stratovolcanoes Transform-fault volcanisms Continental arc volcanisms of Cretaceous Neothetis suture zone Neothetis island-arc complex Neothetis oceanic crust series Sanidinite facies of contact metamorphisms Eclogite and blue-schist facies Triassic high-pressure metamorphism Oceanic crust on the Palaeothetis subduction zone High pressure Alpine metamorphisms Products of high-grade metamorphism Core complex in massives Precambrian ophiolites and island arcs Nappes and ophiolite complexes	**Group d) MINERALOGICAL, ECONOMICAL** Neogene evaporitic mineral beds (trona, borax, soelestine) Type localities of minerals Konyaite, Bursaite and Pandermite etc Lacustrine Sepiolite formations Metamorphic and sedimentary bauxites Thermal spring carbonates Valuable stones and gemological minerals **Group e) STRUCTURAL** Seismically active normal and transform faults Tectonic creeps Structural landforms Tectonically active basins (grabens, pull-aparts) **Group f) GEOMORPHOLOGICAL FEATURES, EROSIONAL AND DEPOSITIONAL PROCESSES, LANDFORMS AND LANDSCAPES** Recent eolian sand dunes Evaporite karsts Modern lakes, wetlands and rivers Modern marine coastal landforms (spits, bars, beaches, lagoons, deltas) Karstic landforms (obruks, sinkholes, dolins, polje, caves) Glacial landforms and deposits Canyons and valleys Erosional landscapes Volcanic landscapes **Group g) ASTROBLEMS** **Group h- CONTINENTAL OR OCEANIC SCALE GEOLOGICAL FEATURES, PLATE RELATIONSHIPS** Foreland trust belt of Afro-Arabian plate **Group i) SUBMARINE** **Group j) HISTORICAL AND CULTURAL** Antique marble and ore mines The sites where the geological terms firstly defined Local and specific building stones

“Global Geoparks of UNESCO” meeting in Greece

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A meeting for the new programme “Global Geoparks of UNESCO” took place 9.3.16 in Athens, Greece.

Mrs Aikaterini Tzitzikosta, president of the UNESCO Greek National Committee, and Prof. N. Zouros, coordinator of the Global Geoparks Network, invited us at the premises of Ministry of Foreign Affairs, where Greek UNESCO has its office. Mrs TZitzikosta welcomed the audience and a number of politicians and Public bodies followed with their addresses. Prof. N. Zouros presented the new UNESCO program Global Geoparks, while Dr Ch. Fassoulas, coordinator of the Greek Geoparks Forum presented the Geoparks Networks: Global, European, and Greek. Representatives of the five Greek geoparks, Lesvos, Psiloritis Crete, Chelmos-Vouraikos Peloponnese, Vikos-Aoos Epirus, Sitia Crete, presented theire areas. The Geopark Troodos in Cyprus was presented by the deputy director of the Cyprus Geological Survey.

All presentations were interesting and well made, the posters and the distributed material very rich, informative and of good taste. The meeting was very successful with a great number of participants from Mass Media, politicians, local governments, state bodies, geoparks, geoscientists, all interested to hear, to ask, to learn, to propose. The event with the well scheduled programme kept undiminished the interest of the audience from 11 am to 3 pm, without break.

The chair of the geological heritage conservation Committee of the Greek Geological Society and member of ProGEO Ex.Com., Ir. Theodosiou, saluted the meeting with a text given to the Mass Media and the participants together with the material of the event. The text refers in headlines to the history of the committee and of the geological heritage conservation concept in Greece, Europe and the world, the status in respect to geosites and geoparks in the country. It focused the need for a systematic recording, evaluation, official recognition and eventually protection of a Dynamic List of geosites, being present as a tool in all land use and negotiations of its planning. There exist several lists made for several purposes and a representative number of recorded geosites to be included, enough experience and even legislation. What we need is the participation of all of us geoscientists and the support of the state to materialize the target. The Committee can play an important role for this.

The text also highlighted that the European geoparks network was established in 2000 with 4 founder members one of which the Lesvos petrified forest. The spread of geoparks in Greece, Europe and the world since then, is impressive. The new Unesco program for geoparks, as a result of big efforts, is a great success and satisfaction. In Greece we have five geoparks and there are others as candidates to come. The situation in respect to geoparks go well and hopefully will even go better in the future.

What we urgently need is the recording, promotion and management of a dynamic National List / Data Base of Geosites on national, regional and local levels, with the support of the State, with the cooperation and help of all relevant national and international bodies. Significant geosites of international interest are destroyed like the fossiliferous Epidaure marbles with the famous ammonites fossils, or are under risk like the palaeontological site of Pikermian fauna in Pikermi Attica, or the unique minerals in Serifos island or in Lavrion area, which undergo illegal collections, or fragile dune areas destroyed due to unregulated urban development. These are indicative examples of the existing situation.

It is sure that geoparks even expanding in area and number, cannot cover the need for a general conservation of geosites. Geosites even of great importance outside the geopark area cannot be saved by their existance. The question is also how many geoparks a country can have. If we accept that some geosites can survive due to their beauty and the impression they provoke, it is not the same for vulnerable sites very significant for education, geological history and science but very discrete and not impressive in their looks.

The procedure should start immediately, the systematic geosites list must be completed, with a serious support of the State.

United Nations Educational, Scientific and Cultural Organization · UNESCO Global Geoparks

Emerging Potential and Challenges for Geoconservation Activities in Japan

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The Japanese Archipelago is an interesting location to study Planet Earth's dynamic mechanisms and their influence on landscape and human life. There are 8 UNESCO Global Geoparks in Japan, as well as 31 national geoparks. Most geoparks are based on two dominant features of the planet that shape the formation of the Japanese Islands: plate (tectonic) motion and volcanism. These aspects of planetary dynamics are also frequently associated with loss of life and property (sometimes at colossal scales as the 2011 earthquake and tsunami disaster in the Northeastern part of the country testified). But at the same time, the geological setting of the country at a junction of multiple plates offers a unique opportunity to study these phenomena at almost regular intervals. Indeed large natural disasters here occur at human timescales—often within a single generation—and as a result, there is a high potential for research on the impact of the planet's physical forces on the living memory.

There is one more aspect that deserves attention for research and evaluation of geoheritage on this part of the planet. This is the overlapping of geological and geomorphological events on the same landscape due to a high rate of weathering and denudation. This idea led us to coordinate an International Session at the annual Japan Geoscience Union Convention in 2015, and a series of workshops within the Japanese Geoparks Network (JGN). Eventually we became aware of the situation that there is a general lack of primary data on the natural and anthropogenic changes to the landscape, and especially on how geosites and geomorphosites (and the mechanism of physical change) may be impacted due to such changes. In this essay we will report on these issues in detail below.

The main event in a series of workshops and talks was the International Session on Geoconservation and Sustainable Development at the Japan Geoscience Union annual convention on 25 May 2015. This was the first occasion where an international session on geoconservation was held in this prestigious congress, and it was also probably the first instance of an international academic session on geoconservation in the country. The main invited speaker for this session was Dr. Murray Gray (Reader Emeritus at Queen Mary, the University

Murray Gray delivering his address at the APGN convention, May 2015 in Tokyo Photo Courtesy: Japanese Geoparks Network

of London) who is a pioneer of the idea of geodiversity, its evaluation, and conservation of the earth's diversity for its intrinsic value. This conference session was preceded by Dr. Gray's invited lecture at the Japanese Geoparks Network National Workshop (supported by Asia Pacific Geoparks Network (APGN), Pro-Natura Foundation Japan and the Research Institute of Manifesto Waseda University) on 22 May 2015 in Tokyo, and was followed by workshops and discussions in two national geoparks from 26 May to 1 June 2015. Discussions during these events ranged from geodiversity evaluation methods to trade-offs between conservation and development and how geoparks should address these issues. It was agreed that as no two geoparks are completely same, geodiversity conservation methods will differ, more due to the human dynamics (stakeholder relationships, applicability of any existing legal framework or the lack of it, awareness level in the local society are some key factors) than the natural variation between sites. However, inventories of primary data for geosite/geomorphosites, physical change parameters, and site-monitoring with the help of scientists and local people are of fundamental importance and common interest.

The first workshop took place at the Hakusan Tedorigawa Geopark at the western seaboard of Japan. At the Tedorigawa River Valley, we could identify numerous stressors on the landscape which impact valley formation processes. The Tedorigawa River originates at Mount Hakusan, one of the three 'sacred mountains' of Japan[1], and flows into the Sea of Japan after a 72 km journey through a largely upland terrain.

The river deposits a large alluvial fan just before merging with the sea: evidence of the heavy bedload it carries due to the large magnitude of erosion, especially at the upper valley. Mass-wasting mechanisms are different at two tributary basins. This difference is a direct result of

[1] Mount Fuji and Mount Tateyama are the other two

The upper Tedorigawa River Valley is heavily engineered by a series of check dams which inhibit the process of mass transport—a key characteristic of a the geomorphology of a dynamic river system

differential erosion mechanisms on metamorphosed igneous bedrock and sedimentary bedrock. The mechanism is a good example of how geological formations lead to different geomorphic properties which in turn lead to landscape diversity. But in the last hundred years the upper part of the river valley has been heavily engineered to stop movement of rocks and silt downstream with check dams. While this approach has been successful in stopping small-scale floods and frequent small-scale slope failures, it had a significant effect on the landscape formation process, and there is no guarantee that the approach would provide security in the event of larger slope failures. The heavy density of check dams at the upper Tedorigawa Valley is a likely factor behind coastal erosion at the lower part of the valley, as these structures have significantly altered the flow and transportation mechanisms of the watershed during the last century. While momentary impact of physical landscaping processes on human life and economy can be large (during landslides or peak discharge events), there is evidence that mass-wasting and mass-transport processes lead to uniquely adapted vegetation and ecosystems. If managed properly with a long-term vision such as innovative tourism schemes, such landscape characteristics could be important economic assets for sustainable development, and have a potential to raise geodiversity awareness.

Huge boulders such as this are evidences of mass wasting and mass transport of large magnitude in the river valley

At the Izu Peninsula Geopark, we could see evidence that even the local population is not usually aware of changes in abiotic environment. This geopark is located close to the Tokyo metropolitan area, and it has a large urban footprint in the form of mass-tourism related development over much of its territory. While many signature geosites are protected by legislation, fragmentation has occurred in the surrounding landscapes at all levels. A good example is found in the northern part of the peninsula where a porous basaltic lava flow from Mount Fuji overlying a relatively impervious older lava formation has created a rich springwater system. The Kakitagawa Spring River, one of the largest springwater systems in Japan, is a 1200 m long stretch of water almost entirely composed of groundwater percolating through the lava formation and oozing through the fissures.

While the Kakitagawa itself is protected, its entire watershed is not, and proliferation of concretized surface and clearing of natural vegetation, as well as excess removal of groundwater for industrial use, have effected a significant drop in the discharge volume of the Kakitagawa over the last half-century. Springwater 'ponds' in the vicinity which do not have protected status fared worse, with some of them completely drying up. Although there are efforts of reviving some part of the environment, the net legacy is a significant fragmentation of the groundwater mechanism and a decrease in the ecosystem services provided by geologic formations; all of which happened within a single average human life-span. Recent efforts of reviving the groundwater environment are mostly focused on the biotic environment (a few key species), but local awareness about the fragmentation of the groundwater mechanism and its geological structure remains low.

Following these workshops, a workshop on geoconservation was organized in the Shirataki Geopark in Hokkaido in July 2015 and a meeting of the Japanese Geoparks Network Geoconservation Working Group was held at the annual convention of the Japanese Geoparks at Kirishima Geopark in October 2015 with the following points summing up the discussions:

1. Most geoparks rely on existing legal protection measures like National Park laws and legislation related to preservation of important natural and cultural assets. While these existing frameworks provide good protection for some cases, they were not created for geoconservaion. Geoparks and researchers should advance the knowhow for geoconservation, and where appropriate, update or supplement the existing frameworks with insights related to geological heritage.
2. Monitoring of the geosites and their surrounding environments is of absolute importance for geoheritage conservation. Geoparks currently lack 'rangers;' and geoguides are not seen as equivalent to rangers. Wherever possible, geoguides should double up as monitors with local support. As geoparks are 'bottom-up' programs, securing local support for activities is the key to their success.
3. Currently there is a lack of primary data on the changes affecting the landscapes at or around geosites/geomorphosites. This issue must be urgently addressed. As there are a number of non-governmental organizations and specialist groups working for natural conservation, geopark professionals should liaise with them wherever possible.
4. There is a need for qualified experts on geoconservation in geoparks. Specialists (geopark professionals) must be representatives of different fields. Geoheritage conservation typically requires multiple methodologies and different skills, and geologists are not always equipped with conservation skills. Integration of knowledge from fields such as geology, geomorphology, geography and landscape management sciences is important. In addition social science experts have a vital role as they can provide a more holistic and critical vision of what is working and what is not.
5. Although geoparks are venues for geotourism, the management system must carefully plan tourism activities in geosites/geomorphosites in order to reduce tourism's impact on the geoheritage of the concerned area. This will not be easy as tourism brings economic benefits, but whenever something is ascribed 'heritage' status, appropriate authorities must ensure that it is conserved for future generations in an optimum condition.
6. Natural change in the landscape is part of the 'geoheritage' concept. Geoheritage is not a static object, in many cases it is composed of dynamic components of the earth system. Natural land formation and landscaping processes are vital for the maintenance of geoheritage and should be understood likewise.

The 'Geoconservation Working Group' of Japanese Geoparks Network formally met at the annual convention of Japanese geoparks at Kirishima Geopark in October 2015. Discussions there led to the formulation of a geoheritage conservation guideline drafted in February 2016. This guideline will be non-binding, but we expect geopark professionals to implement it and enrich it with their own experiences in order to protect geological heritage and promote it in a successful manner. The four important points mentioned in the draft guideline are:

a) Geoparks should have an inventory of different components of geological heritage, including types of sites, distributions and current risk (threat) level.
b) Conservation plan for sites of high value should be formulated by the concerned geopark and its partners.
c) Geosites and related sites should be monitored on a regular basis to identify new threats or to alleviate existing ones.
d) A multi-stakeholder approach is usually needed for geoconservation, geopark management bodies should be proactive in liaising with appropriate experts.

While the history of conscious efforts to evaluate geological/geomorphological heritage is a young one, there is a good amount of social capital associated with many of the signature sites in geoparks in the form of local knowledge and memory, appreciation of the natural beauty, and concern about change. This provides a reason for being optimistic that these ongoing initiatives will be able to attract public support and funding. In the end, ascribing 'heritage' value to something is a method of raising its social value; the geoheritage concept therefore is a vital tool for raising the social value of the diversity of landforms and landscapes that every region of our planet has to offer.

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One of the many 'springs' at Kakitagawa River, formed out of fissures in a porous lava formation of Mount Fuji overlying a relatively impervious older lava flow. Photo Courtesy: Izu Peninsula Geopark

Geosite in Tyrkey: Paratethys marl underlined by continental Quaternary deposits, at coasts of the Black Sea. Photo: Nizamettin Kazancı

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