MOIX Patrice (2010): Contribution to the geology of southern turkey: new insights from the mersin mélanges and from the lycian and antalya nappes.

-Extended abstract-

A geodynamical-oriented geology requires the use of terms which need to be clearly defined. This is particularly the case with the names, definitions and positions of the different oceanic basins involved in the geodynamical history of the Tethysides. The recent developments in the Tethyan geology gave birth to a complicated nomenclature where the several concepts and definitions are often used in different manners, often in strong disagreement with their original significance. The study of fossil Tethyan continental margins implies the revision of the oceanic areas to which they were connected, through palaeontological and sedimentological investigations, but also reconstruction of these domains in space and time. Transition stages between the Variscan orogenic events and the Tethyan rifting phases are crucial for the understanding of plate tectonic in the Tethyan domain: the localization of some parts of the Palaeotethyan suture zone and the recognition of Huğlu-Pindos marginal sequences in southern Turkey and in the external parts of the Hellenides represent one of the main achievements of this thesis. The aim of this study is to help constraining the geodynamical evolution of the East-Mediterranean domain by focusing on some key localities situated mainly in southern Turkey, but also in the adjacent regions of Cyprus and Greece. Through the study of remote and poorly known areas and using a multidisciplinary approach combining palaeontology, tectonics, geochemistry and palaeogeography, the stratigraphy of these key units was clearly established and we propose local and regional correlations.

The Mersin Ophiolitic Complex (southern Turkey) was the starting point of this work. The infra-ophiolitic mélange is subdivided into two units, the Late Cretaceous Sorgun Ophiolitic mélange and the Ladinian-Carnian Hacialanı mélange. The Mersin mélanges, together with the Antalya and Mamonia domains, are represented by a series of exotic units found now south of the main Taurus range and are characteristic of the South-Taurides Exotic Units. The Mersin mélanges consist of the remnants of three major Tethyan oceans, the Palaeotethys, the Neotethys and the Huğlu-Pindos oceans. Palaeotethyan elements were reworked as major olistostromes in the Neotethys basin during the Eo-Cimmerian orogenic event. Neotethyan elements are represented by Middle Triassic seamounts and by broken formations containing typical Neotethyan conodont faunas in the Late Triassic interval. Other elements originated in the Huğlu-Pindos back-arc Ocean and are clearly derived from the former north Anatolian passive margin. These elements are represented by Huğlu-type series including the Late Triassic syn-rift volcanic event. The identification of interstratified limestone levels rich in radiolarians in the latter permitted to establish the early Tuvalian (late Carnian) *Spongotortilispinus moixi* Zone, as well as the next older *Elbistanium gracile* Zone. The Tauric elements are represented by Eo-Cimmerian flysch-like and molasse sequences intercalated in Neotethyan series. Additionally, some shallow-water blocks might be derived from the Bolkardağ parautochthonous and the Taurus-Beydağları marginal sequences. We identified Late Triassic (late Carnian-Norian to Rhaetian) foraminiferal faunas in reefal limestones **in SW Cyprus** which present strong affinities with some localities in the Mersin mélanges and at **the base of the Upper Antalya Nappes** (reworked cobbles in conglomerates whose tectonic position remains unclear). The described microfauna is typical of shallow, high-energy tropical carbonate platforms where reefal structures provide a variety of microenvironments for abundant and diverse foraminifera.

The definition and inventory of **the upper units of the Antalya Nappes, southwestern Turkey** (or Calcareous Antalya Nappes) are still a matter of controversies and often conflicting interpretations. In the Gedeller type locality, we logged a new succession that sheds light on the detailed stratigraphy of the Upper Antalya Nappes. The lower part of the series corresponds to the uppermost part of the Kemer Gorge Nappe and is overthrust by the Ordovician Seydişehir Formation of the Tahtalı Dağ Nappe. The newly described Gedeller Formation belongs to the Kemer Gorge Nappe and is represented by Campanian (Late Cretaceous) Scaglia-type pelagic limestones, which yielded radiolarians of the *Amphipyndax pseudoconulus* Zone. It is demonstrated that the Upper Antalya Nappes system is composed of three different nappes, the Kemer Gorge, Bakırlı and the Tahtalı Dağ nappes. Additionally, a limestone block in an unclear tectonic position **at the base of the Upper Antalya Nappes** yielded two middle Viséan associations of foraminifers and problematic algae. We remark that (a) the Mississippian microfaunas of this block are very close to those of the Hadim Nappes as well as those of the eastern Taurus, and (b) during the latest Devonian (Famennian) and the Carboniferous, the composite Pontides domain, the Taurus terrane, the future Lycian Nappes and the Istanbul terrane have an important number of common microfaunal taxa.

The Lycian Nappes (southwestern Turkey) occupy a key area between the Hellenides to the west and the Taurides to the east. The Tavas Nappe is classically divided into the Karadağ, Teke Dere, Köyceğiz and Haticeana units. The lowermost Karadağ unit consists of a Gondwana-type platform succession ranging from the Late Devonian to the Late Triassic. The Carnian is marked by a general deepening of the platform prior to the deposition of a wildflysch-like formation. The discovery of the Cordevolian (early Carnian) *Pseudofurnishius murcianus murcianus* van den Boogaard conodont fauna on top of the platform is of crucial importance because it characterizes the Westmediterran-Arabian Province (= Sephardic Province) and is a typical indicator for the Neotethyan domain. The Karadağ unit is always found structurally below the Teke Dere unit, this superposition being a possible result of the Late Triassic Eo-Cimmerian orogenic event. The Teke Dere unit is formed by several slices including OIB-type basalts representing a Palaeotethyan seamount, Carboniferous MORB-type basalts, an Early Carboniferous siliciclastic series and a Middle Permian arc sequence. Limestones associated to the seamount yielded an earliest Kasimovian age and the microfauna and -flora share typically biogeographical affinities with the northern Palaeotethyan borders. The Middle Permian fauna is represented by the typical warm, tropical assemblages known at the same time in the Palaeotethys and in the Neotethys. The early carboniferous siliciclastic series are transitionally overlain by early Middle Permian (Kubergandian) limestones and dolomites (Nişangahtepe Fm.). Kubergandian faunal assemblages were also described in reworked cobbles in **the Late Triassic Gevne Fm. in the Aladağ unit (southern Turkey)**. Palaeobiogeographically, we argue that these Kubergandian carbonate microfauna and -flora are well developed along the northern margin of the Palaeotethys. The same conclusion was drawn from reworked latest Early Permian (late Kungurian) cobbles at the base of **the Lentas Unit in southern Crete (Greece)**. The presence of reworked Palaeotethyan sediments at the base of the Lentas unit (base of the Pindos) would suggest a derivation from the Palaeotethyan active margin (arc/fore-arc series). The thick Mesozoic sequence formed by the Köyceğiz and Haticeana series occupies a high structural position above the Karadağ and Teke Dere units. The base of the series comprises a Late Triassic continental sedimentation followed by Liassic shallow-marine limestones and a late Liassic Ammonitico Rosso. The sedimentation continues with late Liassic to Maastrichtian pelagic limestones and calciturbidites, unconformably overlain by a Late Palaeocene to Lutetian flysch. Locally, volcanic rocks associated to Late Triassic pelagic limestones, turbiditic sandstones, and calcareous sandstones alternating with volcaniclastic

sediments form the lowermost exposure of the Köyceğiz series. We came to the conclusion that the Tavas Nappe is highly composite and includes dismembered units belonging to the Palaeotethyan, Neotethyan and Huğlu-Pindos realms. The Karadağ unit belongs to the Cimmerian Taurus terrane and was part of the northern passive margin of the Neotethys (= East-Mediterranean); the Teke Dere succession is composed of several thrust sheets of Palaeotethyan origin. Palaeotethyan remnants found as subduction-accretionary complexes or reworked during the Eo-Cimmerian orogenic event provide a strong mean to identify and locate the Palaeotethyan suture zone; the sedimentological evolution of the Köyceğiz and Haticeana series is in many points similar to classical Pindos sequences. These series originated in the Huğlu-Pindos Ocean along the northern passive margin of the Anatolian (Turkish transect) and Sitia-Pindos (Greek transect) terranes.

Detailed field work and palaeontological evaluations carried out in the above described units led to the elaboration of a global geodynamical model explaining in a synthetic way the palaeotectonic evolution of the Tethysides. The Turkish part of the Tethyan realm is represented by a series of terranes juxtaposed through Alpine convergent movements and separated by complex suture zones. Different terranes can be defined and characterized by their dominant geological background. They are from north to south the Pontides domain (Istanbul, Zonguldak, Rhodope-Strandja, and Sakarya), the Anatolian and the Taurus terranes, plus the South-Taurides Exotic Units and the peri-Arabian domain. These four latter are of particular interest as they are directly involved in the geodynamical evolution of southern Turkey. The Cimmerian Taurus domain together with the Beydağları domain (part of the larger Greater Apulian terrane), were detached from north Gondwana in the Early Permian during the opening of the Neotethys. The drifting Cimmerian blocks entered into a soft collision with the post-Hercynian Eurasia-derived Anatolian and related terranes during the Late Triassic Eo-Cimmerian orogenic phase, thus suturing the Palaeotethys. At that time, the Taurus plate developed foreland-type basins, filled with flysch-molasse deposits that locally overstepped the lower plate Taurus terrane and were deposited in the opening Neotethys basin to the south. These olistostromal deposits are characterized by pelagic Palaeozoic material derived from the Palaeotethyan suture zone (e.g. Mersin mélanges). This led us to propose a plate tectonic model where the Anatolian ophiolitic front is linked up with the Samail/Baër-Bassit obduction front found along the Arabian margin. The obduction front was indented by the Anatolian promontory whose eastern end was partially subducted. Continued slab roll-back of the Neotethys allowed Anatolian exotics ripped during that process to continue their course southwestward until their emplacement along the Taurus southern margin (Mersin) and up to the Beydağları promontory (Antalya-Mamonia) in the latest Cretaceous-Palaeocene. The supra-subduction ocean opening at the back of the obduction front (Troodos-type Ocean) was finally closed by Eocene north-south shortening between Africa and Eurasia. This brought close to each other Cretaceous ophiolites derived from the north of Anatolia and those obducted on the Arabian promontory. The latter were sealed by a Maastrichtian platform, and locally never affected by Alpine tectonics, whereas those located on the eastern Anatolian plate are strongly deformed and metamorphosed, and affected by Eocene arc magmatism.