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The Triassic detrital units in the East-Mediterranean realm: back-arcs opening and Cimmerian collision

P. Moix and G. M. Stampfli
Institute of Geology and Palaeontology, Anthropole, University of Lausanne, Switzerland (Patrice.Moix@unil.ch)

Late Permian and principally Triassic detrital units play an important role in deciphering the geodynamic evolution of the East-Mediterranean area. Some of these units are related to diffuse rifting along the southern margin of Eurasia, whereas others reflect the Cimmerian collision between Gondwana and post-Variscan Eurasia-derived terranes. Several differences within these Triassic detrital units should be noted: they have a different timing of deposition, they are found in autochthonous, para-autochthonous or allochthonous position, and they have different types of substratum and cover series. In addition, the nature of the recycled material is also decisive to make the difference between orogen and rift-related sediments. The investigated sandstones, breccias and conglomerates usually range in age from the Anisian (Scythian?) to the Late Triassic (sometimes Liassic) and are especially well-developed during the Carnian-Norian interval. From the Late Permian to the Late Triassic, the Variscan Cordillera was affected by orogen-scale collapse, leading to widespread rifting, related to slab roll-back of the northward subducting Palaeotethys. This provoked the opening of a series of back-arc basins (i.e. Meliata-Hallstatt, Maliac and Pindos oceans). At the same time, this subduction detached by slab-pull a series of Cimmerian terranes along the northern border of Gondwana and opened the Neotethys to the south of them. The final closure of the Palaeotethys (Cimmerian Event) between the Taurus and the Anatolian terranes produced at places large flysch-molasse deposits often sealed by Jurassic platforms. In southern Europe, the diffuse rifting along the southern margin of Eurasia is recognized in the Carnic Alps. The Carboniferous fore-arc flysch basin (Hochwipfel and Dimon fms) is sealed by a shallow-water sequence of Pennsylvanian–Early Permian age (Pramolo, Rattendorf and Trogkofel groups). The Late Permian rifting is marked by the deposition of the Val Gardena Sandstone and the Bellerophon Fm. This rifting phase is sealed by the Werfen Fm. and the Serla Dolomite. The second phase of rifting is marked by the deposition of the Braies group during the upper Anisian (locally sealed by the latest Anisian-early Carnian Sciliar Dolomite), followed by the deposition of the Buchenstein (“Pietra Verde” pro parte), Wengen (turbiditic sandstones) and San Cassiano Fms until the lower Carnian. This second episode is locally sealed by the Cassian Dolomite and the Val Degano Fm. The third rifting phase is marked by the deposition of the Carnian Dürrenstein Fm, sealed by the late Carnian Raibl Fm. and the Norian Dolomia Principale.
On the Turkish transect, the detrital units belonging to the allochthonous series are post-Variscan Anatolian-derived nappes and are often associated with widespread volcanism. They are generally situated at the base of sequences showing shallow marine sedimentation that pass up to pelagic conditions and finish with flysch/wildflysch deposits. The Meliata-Hallstatt “signal” is well-known in the Silická Brezová composite section (Slovakia). The lower to middle Carnian is made of shallow water limestone followed by a rapid subsidence during the lower upper Carnian and the deposition of pelagic limestones, crinoid limestones, calcarenites and micrites themselves followed by Hallstatt Limestones during the entire Norian and lower Rhaetian. The Maliac “signal” is clearly identifiable in the Karaburun Peninsula. The pelagic development made of limestones and radiolarites usually starts during the Spathian above shallow water limestones. The pelagic sedimentation continues during the middle Triassic and the lower Carnian. During the middle Carnian, the sedimentation passes to shallow water limestones and this situation persists during the Upper Triassic and sometimes even higher up. Volcanic events are common in the Spathian and in the Middle Triassic. Late Carnian cherts associated with pillow-lavas of Maliac origin are found on the northern edge of the composite Anatolian-Tauric platform and were assigned to the opening of the Izmir-Ankara Ocean. The Huğlu-Pindos “signal” may be separated into a Pindos “sub-signal” on the Greek transect and a Huğlu “sub-signal” on the Turkish transect. The Pindos “sub-signal” is usually made of shallow

water limestone from the Permian up to the Anisian, followed by a rapid deepening during the Middle Carnian, and at places already during the upper Ladinian. Widespread mafic volcanism occurs in the middle to upper Carnian. There are also widespread siliciclastics in the middle Carnian, and in this case the pelagic sediments begin with these siliciclastics or immediately above in the upper Carnian. The sedimentation stays pelagic during the Upper Triassic, persists throughout the Mesozoic and ends with the 2nd Pindos flysch during the Palaeocene/Oligocene. The Huğlu "sub-signal" is similar to the Pindos "sub-signal", but seemingly situated in another position within the Pindos-Huğlu Ocean. This signal is marked by a rapid deepening during the middle Carnian above shallow water limestones. The middle to upper Carnian interval is characterized by the deposition of widespread mafic and intermediate volcanism (Pietra Verde-like green tuffs). The sedimentation stays pelagic during the Upper Triassic (cherty limestones), and passes often to a Liassic Ammonitico Rosso followed by Dogger radiolarian cherts. Then these series were transported southward during a late Cretaceous obduction event.

The detrital units belonging to the autochthonous and para-autochthonous series are Gondwana-derived and are often interstratified in platform-type developments ranging locally from the Cambrian to the Miocene. Some of the Triassic units are interpreted to represent the filling of flexural basins (i.e. the Kaşimlar Fm.), and others represent the sedimentation in piggy-back basins (i.e. the Sarpiar Dere Fm.) due to local inversions within the Tauric margin. The Triassic sandstones and conglomerates of the Çayır Fm. are flysch to molasse deposits, but they have been interpreted to be related to flexural uplift and erosion of a rift flank. However, precise analyses and datings of the clasts invalidate clearly this interpretation. Elements from the conglomerates have yielded Upper Carboniferous-Lower Permian pelagic radiolarian cherts, Upper Pennsylvanian Ural-type Fusulinids, Permian pelagic conodonts, Lower, Middle and Upper Permian Fusulinids, Permian and Triassic smaller foraminifers, Lower Triassic pelagic conodonts plus various granites, gneiss, micaschists, quartzites and sandstones. These lithologies are predominantly absent from the Taurus autochthonous, which present a Gondwana-type shallow water development where pelagic strata are never present. Çayır-like sedimentation can be followed over wide areas in Turkey and mark the Eo-Cimmerian unconformity. In addition, conglomerates associated to lower Dogger limestones seal at places Upper Triassic overthrusts, proving de facto a pre-Jurassic tectonic activity due to the Cimmerian collision. These detrital units may be correlated with the Shemshak Formation in the Alborz in Iran where they are clearly associated to the closure of the Palaeotethys and with the base of the Tripolitza Unit known as the Ravdoucha-Tyros beds in Greece. The latter consist of conglomerates, sandstones and violet slates. The elements are polygenic and composed of limestones, sandstones and lydites ranging from Carboniferous to Norian. All these sequences are interpreted as the Eocimmerian flysch-molasse sediments, probably deposited in a foreland basin during a syn- to post-collisional stage between Gondwana and Eurasia-derived terranes.