TECTONIC UNITS AND SUTURES IN THE PONTIDES, NORTHERN TURKEY

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ABSTRACT. The Pontides is made up of three major tectonic units juxtaposed in Mid- to Late Mesozoic times. The Istranca Massif in the west consists of sandstone, quartzite, shale, limestone and Late Permian granitoid deformed and metamorphosed during the Late Jurassic. Its contact with the Istanbul Zone further east is covered by the Eocene sediments. The Istanbul Zone is characterised by a well developed, unmetamorphosed and little deformed continuous Paleozoic sedimentary succession extending from Ordovician to the Carboniferous overlain with a major unconformity by latest Permian to lowermost Triassic continental red beds. The Intra-Pontide Suture of Late Triassic-Early Jurassic age separates Istanbul and Sakarya Zones. In marked contrast to the Istanbul Zone, the Sakarya Zone does not have a Paleozoic basement; Karakaya Complex of Triassic age made up of strongly deformed and metamorphosed basic volcanic rocks, limestones and greywackes with limestone olistoliths forms the basement to the undeformed post-Triassic sediments of the Sakarya Zone. The Karakaya Complex probably represents a Triassic magmatic arc/forearc/trench complex and may be part of a Cimmerian "Continent". The Sakarya Zone is separated from the Anatolide-Tauride units by the İzmir-Ankara-Erzincan Suture. The İzmir-Ankara-Erzincan Ocean must have been in existence during the Triassic as no equivalent of the Karakaya Complex has been found south of the suture. Moreover the Tauride nappes include abundant Triassic pelagic sediments and volcanic rocks representing continental margin deposits of Triassic age.

I. INTRODUCTION

Geologically Turkey consists of a number of microcontinents or blocks separated by suture zones of various ages. The aim of this paper is to evaluate the evidence for the number, extent and age of some of these blocks and suture zones and suggest a revised tectonic schema.

A. M. C. Şengör (ed.), Tectonic Evolution of the Tethyan Region, 109–116.

2. MAJOR FEATURES OF THE BLOCKS AND SUTURES

2.1. Istranca Massif

This large area of metamorphic rocks in Thrace (Figs.1 and 2) forms part of the Kırklareli Nappe of Şengör and others(1). Istranca Massif consists of greywackre, shale, limestone, quartzite and Late Permian granitoid apparently deformed and metamorphosed in greenschist facies during the latest Jurassic. This metamorphic sequence is cut by mid-Cretaceous granitoids and unconformably overlain by Late Cretaceous volcanic rocks 2,3 . The internal structure of the Istranca Massif is very poorly known; especially it might include several tectonic units as yet unrecognised.

Istranca Massif is separated from the Istanbul Zone by a small area of undeformed Eocene sediments (Fig.2); the nature of the contact between these two tectonic units is not known(1). However, the lack of regional metamorphism in the Istanbul Zone indicates that they were juxtaposed in post-Late Jurassic times.

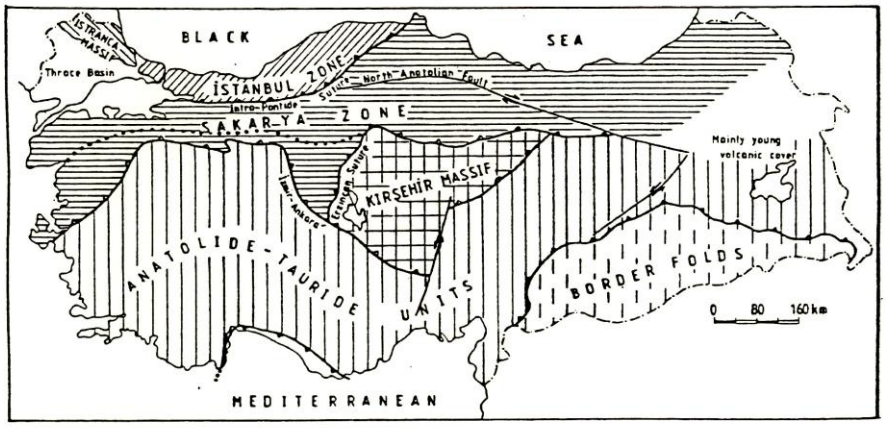

Fig.1. Tectonic map of Turkey showing some of the major tectonic zones. Heavy lines indicate major sutures. Dotted line is the Karakaya Suture after Şengör and Yılmaz(4).

2.2. Istanbul Zone

The Istanbul Zone(5), equivalent to the Istanbul Nappe of Şengör(6), is characterised by a well-developed Palaeozoic section extending without any major break form the Ordovician to the Carboniferous. The Palaeozoic section consists entirely of sedimentary rocks representing an Atlantic-type passive continental margin and rests unconformably on a Precambrian metamorphic basement. The Palaeozoic rocks are overlain with a major angular unconformity by the uppermost Permian - lowermost Triassic continental red beds which passes up to a well developed Alpine-type Triassic carbonate facies overlain unconformably by Late Cretaceous-Palaeocene limestones. The term Istanbul Zone is preferred

to that of the Istanbul Nappe as there is no convincing evidence for the complete allochthoneity of the Istanbul Zone.

The Istanbul Zone is very distinctive from the neighbouring tectonic units in its stratigraphy, absence of metamorphism and lack of major deformation. It is separated from the Sakarya Zone by the Intra-Pontide Suture.

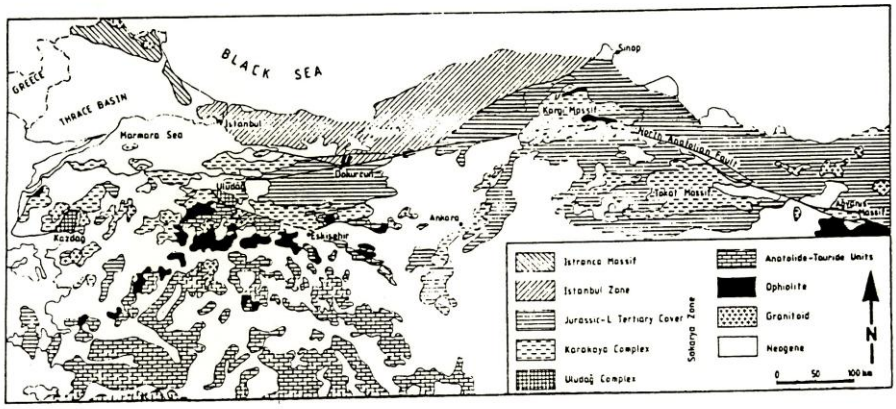

Fig.2. Geotectonic map of the Pontides.

2.3. Intra-Pontide Suture

Şengör and Yılmaz(4) call the Intra-Pontide Suture as the suture of the northern branch of Neo-Tethys which separated their Rhodope-Pontide Fragment from the Sakarya Continent during the Mesozoic. Here, the Intra-Pontide Suture is used to denote the suture separating the Istanbul and Sakarya zones (Fig.1) or more correctly the Palaeozoic of the Istanbul Zone and the Karakaya Complex of the Sakarya Zone.

In stark contrast to the Istanbul Zone, no in situ pre-Triassic rocks are reported in the Sakarya Zone; in fact the Sakarya Zone may not have had a continental basement during the Palaeozoic (see below). Furthermore, no equivalents of the Triassic Karakaya Complex of the Sakarya Zone occur in the Istanbul Zone. All these suggest that Sakarya and Istanbul zones had quite independent and different pre-Jurassic histories. An upper age limit to the juxtaposition of these two zones across the Intra-Pontide Suture is given by the Middle to Upper Jurassic clastics and limestones which lie unconformably over both the Karakaya Complex of the Sakarya Zone and the Istanbul Palaeozoic in the region south of Sinop(1). The Intra-Pontide Suture is the best candidate for the Palaeo-Tethyan suture in Turkey.

The western part of the Intra-Pontide Suture might have been reactivated during the Late Cretaceous. In the region of Dokurcun (Fig.2) Palaeozoic rocks of the Istanbul Zone lie tectonically over an ophiolite and ophiolitic mélange of probable Late Cretaceous age(7). Pelagic limestones, serpentinite and blueschist of probable Late Cretaceous age also occur as fault slivers in southern Thrace 8 . However, the striking similarity in the Mesozoic stratigraphy of the Sakarya Continent of Şengör and Yılmaz(4) and the eastern Pontides indicates that the Cretaceous-Intra-Pontide Ocean did not join into the major İzmir-Ankara-Erzincan Ocean(4) but rather was a narrow, blind-ended Gulf of California type ocean.

2.4. Sakarya Zone

The Sakarya Continent of Şengör and Yılmaz(4) and the eastern Pontides have a very similar stratigraphy and tectonic development which contrasts with the neighbouring tectonic units. These two areas are therefore considered as a single tectonic unit and named the Sakarya Zone(5,9).

The Sakarya Zone is characterised by a variably metamorphosed and strongly deformed Triassic basement called the Karakaya Complex overlain with a major unconformity by Liassic conglomerates and sandstones which passes up to Middle Jurassic-Lower Cretaceous limestones and Upper Cretaceous flysch.

The internal structure of the Karakaya Complex is poorly known. However, it is apparently made up of several tectonic units including a thick volcanic section with abundant basic pyroclastics and tuffs intercalated with carbonates, and a greywacke section with Permian and Carboniferous limestone olistoliths(10,11). The metamorphism where it occurs is generally in high-pressure greenschist facise, and sodic amphibole occurs frequently in basic volcanic rocks 5,12 . The rocks are generally steeply dipping and are strongly deformed with isoclinal folds with subvertical axial planes. The deformation is locally semi-brittle giving a broken formation character to the Karakaya Complex. The Karakaya Complex is also intruded by several pre-Liassic granitoids.

Şengör and Yılmaz(4) terminaţe the Sakarya Continent north of Ankara. However, metamorphic rocks similar to the Karakaya Complex and overlain by Liassic sandstones and conglomerates occur in the Tokat and Ağvanis Massifs(1,13,14). The rest of the Mesozoic stratigraphy of the inner eastern Pontides is also quite similar to that of the Sakarya Continent with the ubiquitous Middle Jurassic - Lower Cretaceous limestones and Upper Cretaceous flysch 15 . There is a gradual passage to a Cretaceous-Eocene magmatic arc towards the outer Eastern Pontides presumably constructed on a Karakaya type basement.

A deformed and variably metamorphosed dark argillite-sandstone sequence locally with abundant limestone, basic volcanic rock and serpentinite olistoliths outcrops over large areas in the Kargı Massif southwest of Sinop (Fig.2, Şengör and others(1). This Akgöl Formation, which forms part of the Küre Nappe of Şengör and others(1), is apparently of mid-Triassic to Early Jurassic age and is unconformably overlain by undeformed Middle Jurassic conglomerates and sandstones passing upwards to Late Jurassic-Early Cretaceous limestones. Here, Akgöl Formation and the Küre Nappe are regarded as part of the Karakaya Complex, as they are lithologically and structurally very similar to it and seem to merge to the Karakaya Complex in the Tokat Massif (Fig.2). Only the deformation and metamorphism may have lasted slightly longer in the Akgöl Formation.

Karakaya Complex probably represents Triassic magmatic arc-trench deposits. The argillite-sandstone sequence with limestone olistoliths may represent a subduction complex(16) whereas the basic volcanic-pyroclastic-limestone sequence may be magmatic arc-forearc deposits. The absence of in situ pre-Triassic rocks in the Sakarya Zone and the dominance of basic volcanism in the Karakaya Complex indicate that the Karakaya Magmatic Arc was constructed on an oceanic substratum. The deformation and metamorphism of the Karakaya Complex may be related to the collision of the magmatic arc with a continent to the north during the Triassic.

The base of the Karakaya Complex is exposed in the Uludağ and Kazdağ tectonic windows in western Anatolia where high-grade gneisses, marbles, amphibolites and metaperidotites occur tectonically beneath the low-grade metabasites of the Karakaya Complex(17). Micaschists and gneisses of the Gümüşhane region in the eastern Pontides may also be part of this Uludağ tectonic unit(18). The age of the Uludağ tectonic unit, and the age of the thrusting are not know. However, these occurrences suggest that the Karakaya Complex is allochthonous and is tectonically underlain by the Uludağ tectonic unit.

Şengör and Yılmaz(4) interpret the Karakaya Complex as a narrow oceanic marginal basin, which opened and closed during the Triassic, and thus show a Karakaya Suture on their maps (Fig.1). However, it is not possible to delineate such a suture in the field, rather as argued here the whole of the Karakaya Complex represents magmatic arc/trench deposits of Triassic age. The Triassic Karakaya Suture may only be exposed in the Uludağ and Kazdağ tectonic windows assuming that the thrusting of the Karakaya Complex over the Uludağ tectonic unit is Triassic.

Rhodope-Pontide Fragment of Şengör and Yılmaz(4) includes in Turkey the Istranca Massif, the İstanbul Zone and the eastern Pontides. However the Cretaceous Intra-Pontide Ocean most probably did not extend into the İzmir-Ankara-Erzincan Ocean so that the Rhodope-Pontide Fragment has never been a discrete palaeotectonic entity during the geological history.

2.5. İzmir-Ankara-Erzincan Suture

This suture separating the Sakarya Zone from the Anatolide/Taurides is generally accepted as being the major Tethyan suture in Turkey. Most ophiolites in the Anatolide/Taurides are believed to have originated from the İzmir-Ankara-Erzincan (IAE) Suture. However, the age of the opening and closing of the ocean along the IAE Suture is not well-established and is quite controversial. Based on sedimentological evidence Görür and others(19) argue for a Liassic opening of the IAE Ocean. However, the IAE Suture abruptly truncates the metamorphic Karakaya Complex along the whole length of the suture (e.g. in the Eskişehir region, in the Tokat and Ağvanis Massifs, Fig.2), and no Karakaya Complex equivalentsare known south of the suture. For the case of Liassic opening of the IAE Ocean, immense lateral movement across the IAE Suture is required to account for the absence of the Karakaya equivalents south of the suture. Furthermore upper level nappes in the Taurides(20) include abundant Triassic pelagic sediments and basic volcanics suggesting that a continental margin was in existence during the Triassic to the north of the Anatolide/Tauride Platform.

Reently discovered Triassic deformation in the Taurides(21) is cited as evidence that the Karakaya Orogeny has also affected the Anatolide/Tauride Platform 1 . However, such Triassic deformation is generally restricted to the southern and external parts of the Taurides and is probably related to the rifting in the Antalya Unit. There is no evidence of Triassic deformation in the Menderes Massif whose metasedimentary cover records continuous sedimentation during the Paleozoic and Mesozoic. A conformable transition from the Triassic clastics to the Liassic dolomites is also observed in the Lycian Nappes east of the Menderes Massif(22).

The question of the age of closure of the IAE Ocean is similarly controversial and unresolved. Şengör and Yılmaz(4) argue for a Late Paleocene - Early Eocene collision of the Anatolide/Tauride Platform and the Pontides. However, based on blueschist evidence Okay(9) prefers a Late Cretaceous age for the final collision. The collision may well have been diachronous starting at Late Cretaceous in northwest Turkey and progressing eastward to the eastern Sakarya Zone where island arc volcanism continues into the Eocene.

3. DISCUSSION

As this review illustrates there are still many unresolved major tectonic problems in Turkey such as the timing of the inital rifting and final juxtapositioning of the different terranes, or the extent of the various tectonic zones. These problems will only be resolved by careful detailed fieldwork aimed to answer particular questions. For example, rift-related or continental margin type rock assemblages, which would indicate the timing of the initial opening of an ocean, have not been

described along the Intra-Pontide or İzmir-Ankara-Erzincan-sutures*. This is partly due to metamorphic overprint but largely due to the lack of recognition of such assemblages. Similarly there is not even a single direct age of the numerous ophiolite bodies thought to have originated from the İzmir-Ankara-Erzincan Ocean. Triassic orogenic events, although very important in the Pontides, are very poarly documented. Very little is known on the internal structure, age of metamorphism, geochemistry of the volcanic rocks and sandstone composition of the Karakaya Complex. With such further data, ideas on the tectonics of Turkey will doubltess undergo major modifications.

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* Editors's note: Rift-related and Atlantic-type continental margin rocks have been described from the Ankara-Erzincan suture zone. See ref.19 and the references cited therein.

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