

# **IGCP 485 MEETING**

**Cratons, metacratons and mobile belts:**

**Keys from the West African craton boundaries**

**Eburnian versus Pan-African signature, magmatic, tectonic and metallogenic  
implications**

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## The Late Pan-African rock-units of Turkey and their geodynamic significance

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Turkey is located between the Gondwanan and Eurasian plates and consists of numerous Alpine terranes with pre-Lower Paleozoic inliers. The differences in the lithologies, ages and distribution of these rock-assemblages suggest the discrimination of a Southern Zone (Taurides and SE Anatolian-Arabian terranes), and a Northern Zone (Istranca and Istanbul-Zonguldak terranes) in Turkey.

### Pre-Lower Cambrian units of the Taurides and SE Anatolian-Arabian terranes

In the alpine autochthonous, para-autochthonous and allochthonous units in the Taurides of the Southern Zone, non-metamorphic to slightly metamorphic pre-Lower Cambrian successions are remarkably widespread (Kozlu & Göncüoğlu, 1997; Gursu & Göncüoğlu, 2001; Gursu et al., 2003).

In the Taurides, the Precambrian rocks outcrop in Sandıklı, Bozburun and Feke regions (Figure 1). In the Sandıklı (Afyon) region, western Taurides, the Precambrian rocks are included in the Sandıklı Basement Complex. It is composed of the low-grade meta-sediments of the Güvercinoluk Formation, intruded by the meta-felsic rocks of the Kestel Cayı Porphyroid Suite (KPCS). The basement complex is disconformably overlain by variegated conglomerates, mudstones with Early Cambrian trace-fossils (Erdoğan et al., 2000) and arkosic sandstones alternating with andesitic-basaltic lavas, followed by siliciclastic rocks and carbonates that yielded Early Middle Cambrian fossils (Dean & Özgül, 1994).

The Güvercinoluk Formation consists of an almost 800 m thick alternation of dark-coloured meta-siltstones and meta-sandstones with olistostromal conglomerates, rare black chert and cherty meta-dolomite lenses. Detrital zircons from this formation in Bozburun yielded a range of Pb/Pb ages between 2522±3 to 657±5 Ma (Kröner & Sengör, 1990). The KPCS is a deformed and highly sheared dome-shaped rhyolitic-dacitic body with a granitic core. Granitoids intrude both the volcanic carapace and the meta-sediments of the Güvercinoluk Formation and yielded youngest single zircon Pb/Pb ages of 543±7 Ma (Kröner & Sengör, 1990). Both the granitoids and rhyolites/dacites are typically dynamometamorphic with relict igneous textures. Geochemical data show that they are mainly calcalkaline and peraluminous. The mantle-normalized incompatible trace element patterns are characterized by distinct negative Ba, K, Sr, Ti and Eu anomalies and display enrichment in Th, Hf and Zr elements. The REE patterns indicate a strong enrichment in LREE but display slightly flat HREE patterns. The (La/Yb)<sub>N</sub> ratios of rhyolite/dacite and quartz porphyries range from 1.77-14.29 and 2.8-13.77 respectively. Distinct negative Eu anomalies are demonstrated by Eu/Eu\* values ranging between 0.0408-0.277 and 0.159-0.340, respectively. Petrogenetic modeling indicate that both the extrusive and intrusive rocks of the KPCS were generated by 25% partial melting and 25% fractional crystallization of an upper continental crust source and affected by FC process. The trace and REE pattern of the meta-igneous rocks of KPCS display similarities to post-collisional A-type granites.

Regarding the metamorphism, the IC values ( $\Delta^2\theta = 0.14-0.27$ , mean = 0.20) of the white micas of the basement complex and the Lower Cambrian cover are similar. However, the  $b_0$  (9.028-9.058 Å, mean = 9.043 Å) values of the basement rocks suggesting the higher parts of the intermediate P to high P facies conditions differ from those of the cover, which are lower ( $b_0=9.004-9.040$  Å, mean = 9.026 Å) and characterize the intermediate P facies conditions (Bozkaya et al., 2003).

Within the metamorphic complexes of the Taurides (Afyon Unit, Menderes and Central Anatolian massifs) and Bitlis Massif in SE Anatolia, equivalents of the pre-Lower Cambrian rocks are found as medium- to high-grade gneisses with amphibolites. The Precambrian basement in Afyon Unit include meta-pelitic rocks, intruded by meta-quartz porphyries and Na-amphibole bearing meta-basic rocks, respectively, and indicate low- to medium-grade metamorphic conditions (Turhan et al., 2003). In the Menderes Massif, Oberhaensli et al. (1997) reported that gabbroic intrusions in the metasediments display eclogitic paragenesis overprinting an earlier granulite facies metamorphism. Augen-gneisses cutting the meta-gabbros yield single

zircon ages of 540 Ma indicating a complex pre-Cambrian polymetamorphic history. In Bitlis Massif in SE Anatolia, the rock-units and metamorphism are very similar to those of the Menderes Massif (Göncüoğlu, 1997).

The lithologies as well as the depositional environment of the pre-Lower Cambrian sediments of the Eastern Taurides (Feke area) can be correlated with similar units of the Western Taurides and the Arabian Platform. The lithological correlation indicates a continuity of them in Salt Range Formation in NE Pakistan, on both sides of the Zagros Suture in Iran (Soltanyeh Formation in the Albruz Mountains and the Rizu Series in Kerman), the Huqf Group in Oman, the Ghabar Group in Yemen and the Saramuj Unit in Jordan. In the last two localities, clastics with bands of stromatolitic limestones are intruded by acid and basic dikes. The dikes in Yemen and Jordan have been dated at 590Ma and 600-640Ma, respectively (Kröner & Sengör, 1990).

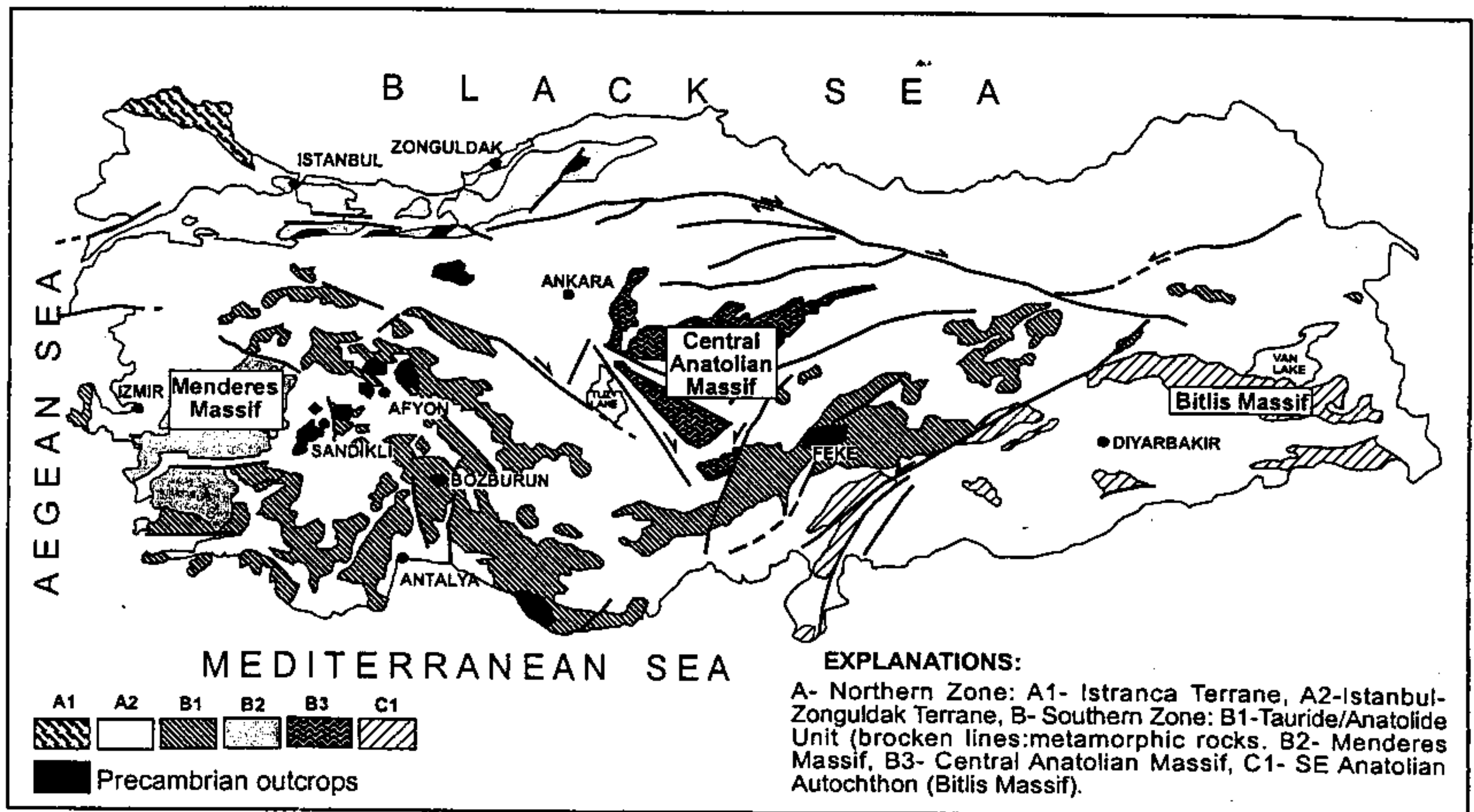


Figure 1- Distribution of Precambrian outcrops in different terranes in Turkey (Göncüoğlu & Kozlu, 2000).

### The pre-Ordovician basement of Istanbul-Zonguldak and Istanca terranes

The pre- Lower Ordovician rocks of the Northern Zone in the Istanbul-Zonguldak Terrane (Precambrian Basement Complex of Göncüoğlu, 1997) are represented by metasediments of continental crust origin and dismembered ophiolites (gabbros, pyroxenites, high-Mg schists/meta-serpentinities, basalts/ortho-amphibolites) intruded by metagranitoides. The metasediments yielded detrital zircons with ages concentrated between 890 to 710 Ma, suggesting a derivation from Gondwana, whereas the tonalitic and granitic granitoids were formed during Late Pan-African magmatic events between 590 and 560 Ma. These rocks have low Nb/Y ratios and Ti contents, consistent with those of the continental arc rocks, which is also supported by the Sr and Nd isotope data (Ustaömer & Kipman, 1997; Chen et al., 2002). Geochemical data from the dismembered ophiolitic lithologies indicate a supra-subduction tectonic setting (Yigitbaş et al., 2001). A similar rock-assemblage is also observed in the Istanca Terrane, but not yet studied in detail. The "Precambrian Basement Complex" of the Northern Zone can be correlated with the Precambrian ophiolites and island-arc associations of the Rhodope Terrane in the Balkans.

### Conclusions

It is suggested that the Pre-Lower Paleozoic continental crust of the Northern Zone with its counterparts in the Rhodope terrane in the Balkan region were located at the northern margin of Gondwana. They were rifted from here by the opening of a back-arc basin above the southward subduction of the Eastern Iapetus oceanic lithosphere that initially separated the Northern and Southern zones. In the former, the arc

itself is represented by the 590 to 560 Ma old calcalkaline granitoids. The supra-subduction-zone type ophiolites in this zone correspond to the lithosphere of the Eastern Iapetus Ocean. The juxtaposition of the continental arc and the oceanic assemblages has very probably lasted until Late Cambrian.

The metasediments (Güvercinoluk Fm.) of the Southern Zone with detrital zircons of Pan-African age were deposited in basin-and-range-type narrow zones (transtensional basins, Kozlu & Göncüoğlu, 1997) on the Pan-African consolidated basement. The formation of the 543 Ma (Kröner & Sengör, 1990) old A-type granitoids within the metasediments of the Southern Zone is ascribed to the post-collisional extension related to the rifting mentioned above. This extension has very probably also triggered the very low-grade metamorphism in the Güvercinoluk Formation. The Early Cambrian basaltic/andesitic rocks within the Taurus units (Gürsu et. al., 2003) were also developed in back-arc basin setting, related to the S-ward subduction of the Iapetus oceanic lithosphere.

To conclude, the metasedimentary assemblages of both the Northern and Southern zones in Turkey represent the northern part of Gondwana. This interpretation contrasts with the suggestion of Kröner & Sengör (1990) that the Taurides were in close proximity of the Angora Craton of Siberia during the Late Proterozoic period. The separation of the Istanbul-Zonguldak (and probably also Istranca) terranes resulted in the opening of a marginal basin between them.

On the other hand, based on geological, geochemical and petrogenetic studies, it is suggested that the Precambrian felsic magmatism within the Southern zone was generated in a similar tectonic setting as the post orogenic A2-type Late Pan-African or Late Cadomian granitoids in the Gondwanan terranes in North Africa (Younger Granitoids and Amram Massif), southern Europe (Spain, France, Bohemia, Brno Massifs) and western Turkey (Menderes Massif) during the Late Pan-African period.

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