



# Proterozoic ophiolites and mafic–ultramafic complexes marginal to the İstanbul Block: An exotic terrane of Avalonian affinity in NW Turkey

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## ABSTRACT

Among the Proterozoic inliers in the İstanbul Block, the lowest structural levels are exposed in the Sünnice Massif, north of Bolu. Amphibolite-facies mafic and subordinate ultramafic rocks of the Çele meta-ophiolite underlie the greenschist-facies Ediacaran calc-alkaline Yellice metavolcanics, which are intruded by the ~565–576 Ma Dirgine granitoids. Hornblende gneisses of the Çele meta-ophiolite comprise island arc meta-tholeiites and transitional to calc-alkaline metabasalts which, together with minor serpentinite are disposed in a broadly antiformal structure. The meta-ophiolitic rocks are therefore the oldest ophiolites in NW Turkey, and are themselves thrust on to a putative pre-existing continental margin, now represented by the metasedimentary migmatites of the Demirci gneisses, which may thus be the oldest rocks of the complex. The İstanbul Block is an exotic terrane. Unlike other western Turkish terranes, it lacks Variscan metamorphism: its different provenance, indicated by its geological record, faunal affinities, and inherited mid-Proterozoic isotopic dates, suggests a former link with Avalonian basement in England, NW Europe and the Maritime Provinces of Canada. Hence, together with other terranes now situated further east than the Avalonian terranes of NW Europe, the İstanbul Block may represent the easternmost extremities of Avalonia, which were detached during its end-Ordovician collision with the Bruno-Silesian Promontory on the SW margin of Baltica. Subsequent migration of the İstanbul Block to its present location occurred by eastward displacement by sinistral transpression along the southern margin of Baltica to a point east of the Dobrogea and south of the Scythian Platform, followed by collision with the Sakarya Block in the Mesozoic and Late Cretaceous southward displacement with the opening of the Black Sea basin.

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## 1. Introduction

The İstanbul Block of northwestern Turkey possesses a distinctive stratigraphic sequence. It is unique in northern or western Turkey in containing a little-deformed and largely unmetamorphosed Palaeozoic sequence, extending virtually unbroken from the Ordovician to the Carboniferous. The lack of post-Carboniferous Variscan metamorphism distinguishes the İstanbul Block from other components of the Pontide Belt of northern Turkey. While its Palaeozoic sequence has been compared with that of Variscide terranes in Europe, such as Cantabria, the Montagne Noire and Sardinia (Yiğitbaş et al., 2004), its late Ordovician rocks lack the glaciogenic sediments which characterize most Variscide peri-Gondwanan terranes, and this makes correlation with such terranes questionable. Instead, comparison of early Palaeozoic faunas (Dean et al., 2000) and the presence in late Neoproterozoic granitoids of zircons preserving middle Proterozoic

(‘Rodonian’) inherited ages (Chen et al., 2002), has led to suggestions of a link between the İstanbul Block and Avalonia-related terranes (Winchester et al., 2006).

The southern margin of the İstanbul Block is now marked by the currently-active dextral transcurrent North Anatolian Fault Zone (Fig. 1). This major fracture is exploiting the weakness of, and reactivating displacement along the original suture zone marking the contact between the İstanbul Block and the Sakarya Block to the south. Close to this southern margin of the İstanbul Block, inliers of Proterozoic rocks are exposed, unconformably overlain by basal Ordovician conglomerates and sandstones.

These inliers of Proterozoic rocks are now well described (e.g., Yılmaz et al., 1981; Ustaömer and Rogers, 1999; Yiğitbaş et al., 1999, 2004; Ustaömer et al., 2005; Okay et al., 2006). They extend from the Armutlu Peninsula in the west (which has been in some previous interpretations assigned to the Sakarya Block) to the Karadere area in the east, a distance of over 300 km (Fig. 1). They contain several distinct components, some of which have been previously dated (e.g., Chen et al., 2002). In this study, the meta-ophiolitic rocks from the Sünnice area have been sampled geochemically in conjunction with structural studies.

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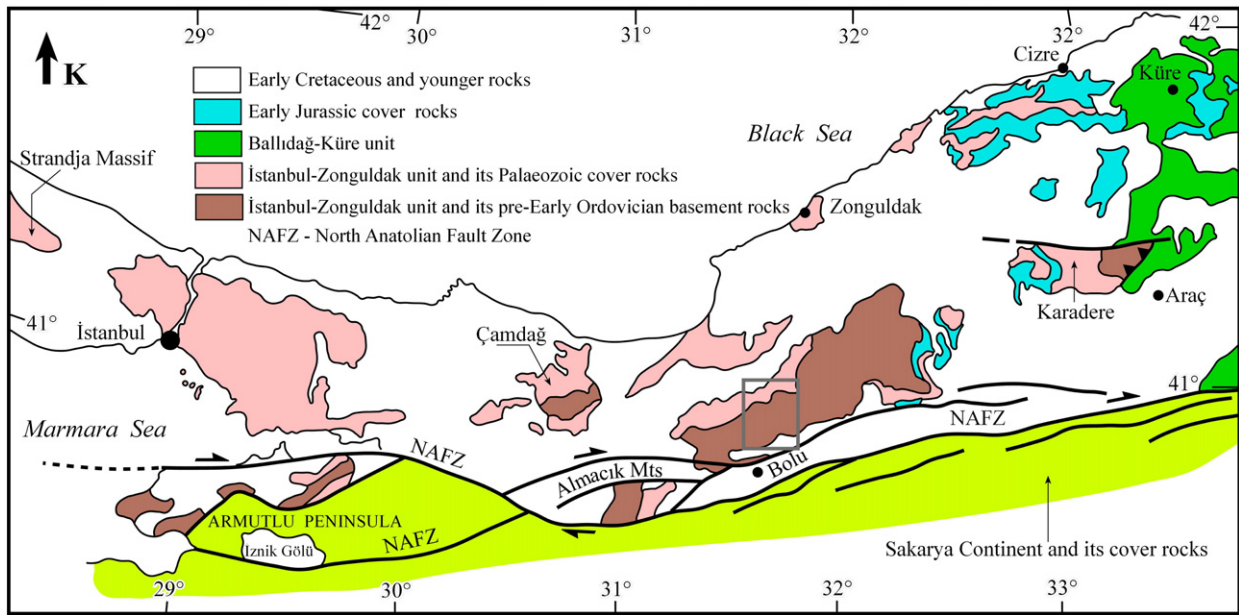


Fig. 1. Simplified geological map of İstanbul Block showing inliers of Proterozoic rocks and their Palaeozoic cover rocks. The rectangle shows the location of Fig. 2 (from Yiğitbaş et al., 2004).

On the southern slopes of the Sünnice Mountains, north of Bolu, hornblende gneisses, which crop out over 30 km<sup>2</sup> and exceed 2500 m in thickness, have been recently interpreted (Yılmaz et al., 1995;

Yiğitbaş et al., 1999, 2004) as a meta-ophiolite, and termed by the latter the Çele meta-ophiolite (Fig. 2). Together with the dominantly basaltic, dacitic and rhyolitic Yellice metavolcanic rocks, they are cut by the

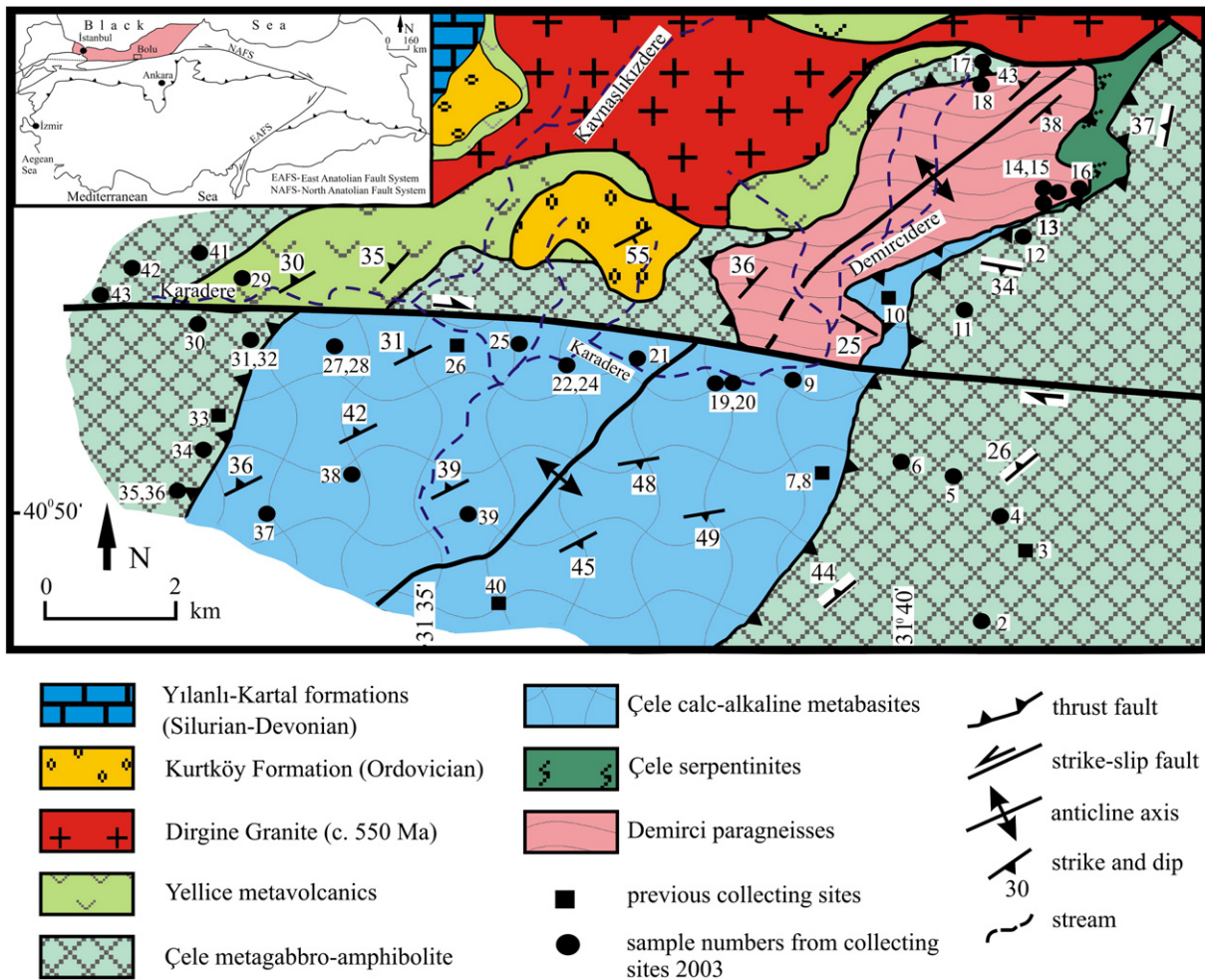


Fig. 2. Map showing the setting and field relationships of the Sünnice Massif. Locations of numbered samples along the principal road sections are given. Inset shows its location in northwest Turkey (from Yiğitbaş et al., 2004).

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