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Inferences on the Mesozoic evolution of the North Aegean from the isotopic record of the Chalkidiki block

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ABSTRACT

The Chalkidiki block is a major domain in the North Aegean that, contrary to other domains in the region, largely escaped thermal perturbations during Tertiary extension. As a result, the Chalkidiki block is an ideal candidate to glean information related to the timing of Mesozoic thermal events using appropriate geochronological techniques. We have undertaken a laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) study (U-Th-Pb on monazites and U-Pb on zircons) coupled with $^{40}Ar/^{39}Ar$ dating on nine samples from various structural levels within the thrust system of the Chalkidiki block. The eastern, and structurally lower part of the system revealed a complete isotopic reset of Carboniferous – Early Triassic monazites coeval with partial monazite destruction, REE-mobilisation and formation of apatite-allanite-epidote coronas at ~132 Ma, a reaction that is commonly observed in amphibolite-facies rocks. These coronas formed after crystallisation of garnet (i.e., at T > 580 °C) and, in all probability, either close to the peak-temperature conditions (~620 °C) on a prograde path or during retrogression between the peak-temperature and the low-temperature boundary of the amphibolite facies. Cooling of these rocks and arrival at mid-crustal levels occurred at 95–100 Ma. By contrast, the western, and structurally uppermost part of the system went through the same event by 120–125 Ma. Further structural considerations with respect to medium-temperature geochronology data imply that syn-metamorphic thrusting must have ceased by early Late Cretaceous. We emphasize that, with the sole exception of the Chalkidiki block, no pre-45 Ma medium-temperature geochronology data are preserved in other North Aegean domains, a feature that is clearly related to the extension-induced thermal perturbation of the region during the Tertiary.

1. Introduction

The Hellenic Thrust Wedge resulted from the Mesozoic to Early Cenozoic Eurasia-Africa convergence manifested by (i) the southward-verging accretion of three continental blocks (van Hinsbergen et al., 2005), namely, from top to base, the Rhodopia, Pelagonia and the External Hellenides, and (ii) the closure of two intervening oceanic domains along the two suture zones of Vardar-Axios and Pindos (Robertson, 2002; Papanikolaou, 2009, 2013) (Fig. 1). Extensional inversion of the Hellenic Thrust Wedge that initiated in Early Cenozoic corresponds to gravity spreading with a rate controlled by the velocity of the trench retreat (Gautier et al., 1999; Jolivet and Faccenna, 2000; Brun and Sokoutis, 2010; Jolivet and Brun, 2010; Kydonakis et al., 2015a; Brun et al., 2016).

The Mesozoic convergence history has received significant attention leading to regional considerations for the hinterland of the Hellenic Thrust Wedgecollectively known as the Rhodope (Burg et al., 1990, 1996; Ricou et al., 1998). Following the discussion in Kydonakis et al. (2015a), the Rhodope can be divided into three distinct domains that are, from northeast to southwest, the Northern Rhodope Domain, the Southern Rhodope Core Complex and the Chalkidiki block (Fig. 2). The Northern Rhodope Domain and the Chalkidiki block arguably participated in the same Mesozoic metamorphic event(s) experiencing, however, different tectono-thermal histories whereas the Southern Rhodope Core Complex (and the time-equivalent Northern Rhodope Core Complex) developed exclusively during the Middle Eocene-Miocene Aegean extension (see Kydonakis et al., 2015b and discussion therein).

The exact timing of these metamorphic event(s) in the north Rhodope is often accessed by geochronology studies (e.g., Reischmann and Kostopoulos, 2002; Liati et al., 2011) the results of which are commonly tested against regional structural analysis (e.g., Ricou et al., 1998; Krenn et al., 2012). Although the peak eclogite-facies metamorphic event is generally accepted as being Jurassic in age, with some controversy

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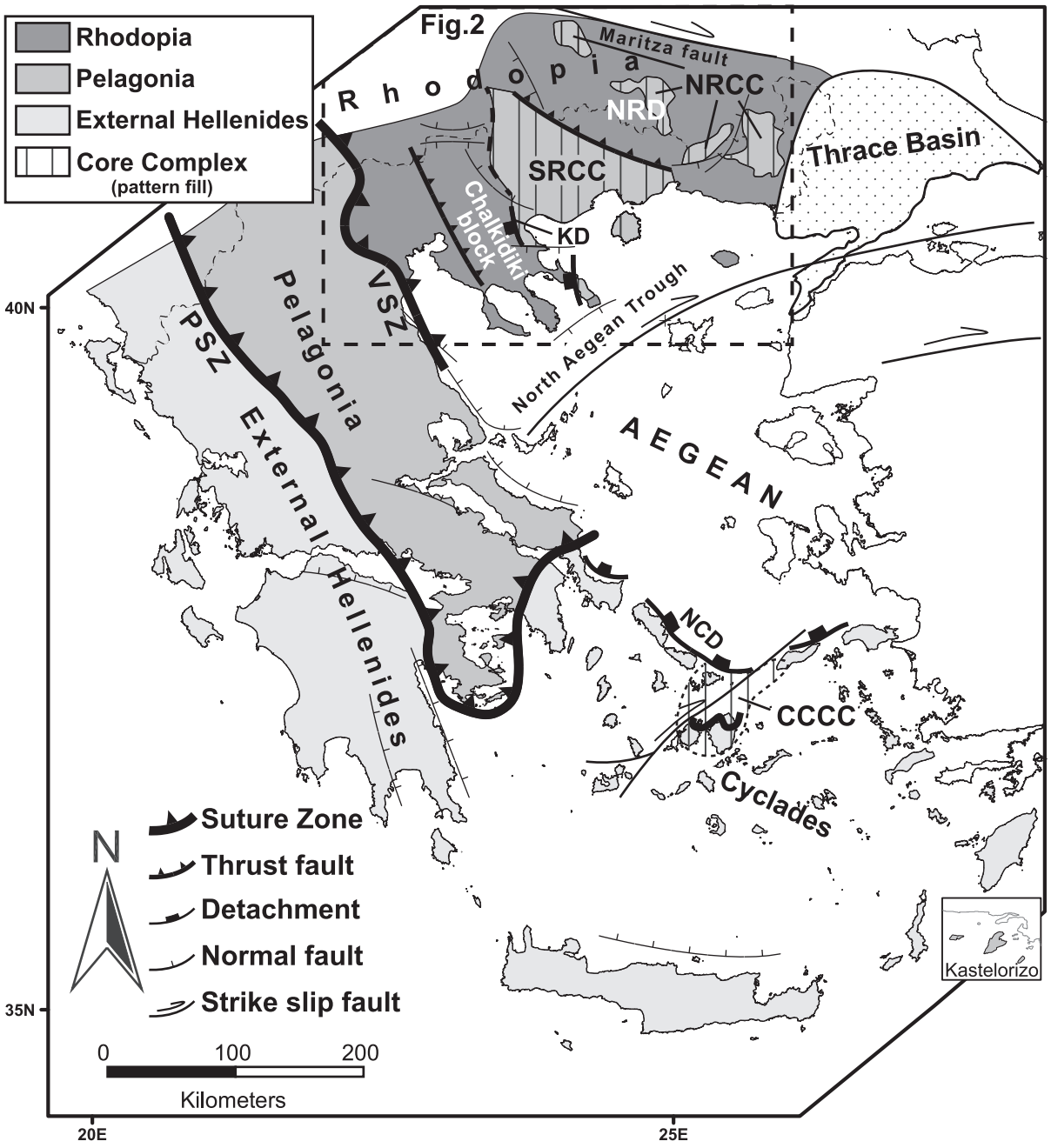

Fig. 1. Simplied geological map of the Hellenides showing the three continental blocks of Rhodopia, Pelagonia and External Hellenides and the two intervening sutured oceanic domains of Vardar and Pindos. NRD: Northern Rhodope Domain, NRCC: Northern Rhodope Core Complex, SRCC: Southern Rhodope Core Complex, CCCC: Central Cyclades Core Complex, KD: Kerdylion Detachment, NCD: North Cycladic Detachment.

involved (see Burg, 2012; and references therein), the post-peak thermal history is not explicitly constrained with respect to the Mesozoic cooling. This is likely due to (i) extensive reworking during the Cenozoic extension coeval with gneiss domes formation, widespread igneous activity and the related high thermal gradient and (ii) absence of application of medium-temperature geochronology methods on non-affected lithologies within appropriate domains. In fact, medium-temperature geochronology data ($^{40}Ar/^{39}Ar$ on micas) point mostly toward an Eocene - Miocene age which can be only linked to the Tertiary extension (e.g., Lips et al., 2000; Bonev et al., 2013). The Chalkidiki block, the southern domain of the Rhodope, largely escaped the thermal effects of the Tertiary extension and, therefore, constitute an ideal candidate to define the Mesozoic post-peak metamorphic evolution in the North Aegean.

In this contribution we present new $^{40}Ar/^{39}Ar$ (micas) and LA-ICP-MS (monazite and zircon) ages from the Chalkidiki block. Our results are analysed and interpreted under three complementary perspectives: (i) the timing of the regional amphibolite-facies metamorphism as well as the post-peak thermal cooling, (ii) the end of syn-metamorphic thrusting and (iii) the significance of tectonic/metamorphic events recorded at the scale of the Rhodope Metamorphic Province.

2. Geological setting

2.1. The Rhodope Metamorphic Province

The Rhodope Metamorphic Province, or simply the Rhodope, constitutes the hinterland of the Hellenides (northeast Greece - southwest