On the origin of some Eohellenic ophiolites : commentary on Clift & Dixon 1998 : Jurassic ridge collapse, subduction initiation and ophiolite obduction in the southern Greek Tethys (Eclogae geol. Gelv. 91/1)

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Objekttyp: **Article**

Zeitschrift: **Eclogae Geologicae Helvetiae**

Band (Jahr): **91 (1998)**

Heft 3

PDF erstellt am: **29.04.2024**

Persistenter Link: https://doi.org/10.5169/seals-168434

0012-9402/98/030431-4 $1.50 + 0.20/0
Birkhäuser Verlag, Basel, 1998

Eclogae geol. Helv. 91 (1998) 431–434

On the origin of some Eohellenic ophiolites

(Commentary on Clift & Dixon 1998: Jurassic ridge collapse, subduction initiation and ophiolite obduction in the southern Greek Tethys. Eclogae geol. Helv. 91/1)

RUDOLPH SCHERREIKS

Clift & Dixon (1998) presented structural and geochemical data from the Migdhalitsa Ophiolite of the Argolis peninsula and they proposed a model for the evolution of this unit and its emplacement onto the Pelagonian micro-continent. After having considered shear-fabric and palaeomagnetic data, these authors concluded that the Migdhalitsa Ophiolite was derived from the western, Pindos oceanic suture. However, this conclusion is controversial in the light of the work of previous authors (Jacobshagen 1979, Vrielynck 1982, Baumgartner 1985), and it appears to be erroneous in consideration of the palaeogeographic reconstructions of the Hellenides by Stampfli et al. (1991), which have been affirmed recently (Stampfli & Mosar 1998; Stampfli et al. 1998): at the time of ophiolite emplacement, during the Late Jurassic, the Pindos ocean was situated south of the Pelagonian micro-continent and the Vardar ocean was located north of this terrane (see also Kissel & Laj 1988 and Turnell 1988). Moreover, in their discussion, Clift & Dixon suggested that numerous obducted Hellenic ophiolites of Late Jurassic age (defined as Eohellenic ophiolites by Jacobshagen et al. 1976), including those of Evvoia (Euboea), which, like the Migdhalitsa Ophiolite were thrust onto the Pelagonian zone, should have had a common origin in a western Tethyan basin. Clift & Dixon cite authors who support their hypothesis, without indicating that opposing hypotheses exist (Mercier, 1966; Bernoulli & Laubscher, 1972; Dercourt, 1972; Zimmerman, 1972; Zimmerman & Ross, 1976; Jacobshagen et al., 1978). [Recently, the latter supporters of a Vardar origin of the Eohellenic ophiolites have gained significant support by Stampfli & Mosar (1998), who showed that the Pindos arm of the Palaeotethys had already closed by Carnian times, and in the case of the Eohellenic ophiolite in NE-Evvoia, Scherreiks (1998) substantiates that thrusting was from the palaeogeographic north and not from the west.]

Initially Clift's & Dixon's arguments conform to the data:

- the present attitudes of the shear fabrics (Clift & Dixon 1998, Fig. 12) indicate a thrusting direction from the NE (an origin of the ophiolite from the east was previously also established by Baumgartner 1985);
- the deformation of the Hellenic arc during the post-Eohellenic era (Kissel & Laj, 1988) caused regional rotations, whereby the Argolis peninsula was rotated clockwise up to 70° (Turnell 1988), or perhaps even as much as 107° (Clift & Dixon 1998);
- therefore, the restored palaeogeographic direction of Late Jurassic, Eohellenic, thrusting was from about the NW toward about the SW.

However, the puzzling thing is that Clift & Dixon concluded the Migdhalitsa Ophiolite was derived from the Pindos zone, which, according to palaeomagnetic data (Kissel & Laj 1988) and modern palaeogeographic reconstructions, was situated south of the Pelagonian zone (Stampfli et al. 1991). This reconstruction of Hellenic palaeogeography was not taken into consideration by Clift & Dixon in their discussion, so that their grounds for supposing a Pindos origin for the Migdhalitsa Ophiolite appear to be rather one-sided. An additional critique is that Clift & Dixon presented in Figure 2 a schematic road-cut sketch without scale nor compass directions. Verification that the ophiolites of Argolis were derived from an easterly direction (present direction) can be found in the actual geologic cross sections shown by Baumgartner (1985). An open question remains, however, concerning the accuracy of the restored thrusting direction established by Clift & Dixon, as no pole diagram for bedding is presented, without which a correction for eventual subsequent tectonic tilting of the shear fabrics cannot be made. In conclusion, After taking post-Eohellenic

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regional rotations into consideration, the shear-fabric data shown by Clift & Dixon (1998) indicate that the Migdhalitsa Ophiolite was probably derived from an ocean basin that was located palaeogeographically about to the north-west of the Pelagonian terrane, where, according to recent and latest reconstructions, the Vardar ocean evolved (Stampfli et al. 1991; Stampfli & Mosar 1998; Stampfli et al. 1998). Palaeogeographic evidence is lacking to support Clift & Dixon's conclusion that the Migdhalitsa Ophiolite was derived from the Pindos oceanic suture. This critique is neither directed towards Clift's and Dixon's interpretation of their geochemical data nor in principle towards their plate tectonic model.

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Reply

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We thank Rudolph Scherreiks for his detailed comments on our recent paper and for highlighting certain areas of special tectonic significance for reconstructions of the Hellenides. He is indeed correct in saying that the origin of the Subpelagonian ophiolites remains a controversial issue and we would like to take this opportunity to clarify some of the points raised, as they are important not only to reconstructing the paleoceanography of the Neotethys, but also to understand the tectonics of ophiolite formation and obduction. Traditionally the Migdhalitsa, as well as several other Hellenic Ophiolites (e.g. Pindos, Othris), have been considered as being derived from an eastern Vardar strand to the Neotethys that sutured during the Late Jurassic (Jacobshagen 1979; Vrielynck 1982; Baumgartner 1985). Alternative models have focused on the origin of the ophiolites and the timing of closure of the western Pindos and the eastern Vardar branchs of the Neotethys. The confirmation of Triassic-Eocene deep water pelagic and continental margin sediments within the Pindos Zone in the Peloponesos (Fleury 1980; Green 1983; Degnan & Robertson 1991, 1998), as well as in the Pindos Mountains of Northern Greece (Dio Dendra Group; Jones & Robertson 1991), indicates the presence of a deep water basin west of the Pelagonian Platform until final continental collision in the Paleogene. This is incompatible with Stampfli & Mosar's (1998) conclusion that suturing occurred in the Carnian (M. Triassic). Moreover, the identification of oceanic basalts of Late Cretaceous age in the Adheres Peninsula of southern Argolis, in contrast to the Jurassic Ophiolites of central and northern Argolis (Clift & Robertson 1989) and possibly also on the island of Evvia (Robertson 1990) demonstrate that a true oceanic basin remained open east of the Pelagonian Platform until the Eocene (cf., Stampfli et al. 1991; Stampfli & Mosar 1998).

45° rotation of peninsular Greece during the Neogene by bending of the Aegean Arc (Kissel & Laj 1988; Morris 1995) has accentuated the angular difference between the strike of the Hellenides and their continuation in western Turkey. However, the Aegean bend in the Alpine fold belts is not entirely a Neotectonic feature and reflects a real change in paleogeography, most markedly shown by the different ages of ophiolite obduction in Greece (Late Jurassic) and Turkey (Late Cretaceous). This difference was not recognized by Stampfli et al. (1991) and means that the Pindos suture lay SW not S of the Pelagonian Platform in southern Greece. This difference is important because the 90–107° rotation of the Argolis (Morris 1995) would restore a SSW-directed ophiolite obduction vec-