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New stratigraphic data of the Limnos volcano-sedimentary sequence and correlations with the Thrace Basin

D. Papanikolaou[1], M. Triantaphyllou[1]

(1) Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Panepistimioupolis, 15784 Athens, Greece, mtriant@geol.uoa.gr

Introduction

The geological structure of Limnos Island comprises a clastic sedimentary sequence of Oligocene age with extensive volcanic rocks of Lower Miocene age (Innocenti et al., 1994, 2009). The available geological maps (Roussos, 1994; Innocenti et al., 2009) do not comprise a stratigraphic subdivision with distinct stratigraphic formations but a description of the dominant lithology. The available stratigraphic and sedimentological studies (e.g., Caracciolo et al., 2011; Maravelis and Zelilidis, 2012; Kostopoulou et al., 2018) do not present a coherent tectono-stratigraphic structure of the island and their conclusions are referring to an Upper Eocene - Oligocene stratigraphic range with a total thickness of less than 800 m.

Our research comprised geological mapping, combined with several stratigraphic sections from the lower to the upper horizons and tectonic analysis combined with calcareous nannofossil biostratigraphy (Martini, 1971; Agnini et al., 2014).

Results

Our results have shown that: 1) Limnos volcano-sedimentary sequence exceeds 2200 m of thickness and 2) the stratigraphic range extends from the Late Eocene (nannofossil biozone NP17, around 38–40 Ma) to the Oligocene/Miocene boundary (nannofossil biozone NP25 around 24–25 Ma and up to 23 Ma within biozone NN1).

Characteristic stratigraphic assemblages are:

- The lower horizons, cropping out in Southeast Limnos at Bay Agias, are more than 300 m thick and their age is of Late Eocene (NP17), comprising a nannofossil assemblage of Helicosphaera compacta, Sphenolithus predistentus, S. spiniger and S. obtusus.

- An overlying distinct horizon, cropping out along the crest of the NW-SE trending hill of Southeast Limnos east of Fissini, consists of a blocky formation with olistolites of Nummulitic neritic limestones. This horizon occurs about 100–120 m above the lowermost rhythmic alternations of turbiditic sandstones and pelites belonging to the Late Eocene (nannofossil biozone NP17) with H. compacta, S. obtusus, Dictyococcites bisectus and Reticulofenestra umbilicus.

- Another distinct horizon about 150–200 m higher than the blocky formation consists of several interlayering volcanic tuffs within a cyclical sedimentary sequence exposed at Cape Ag. Eirini. It has been dated as Late Eocene-Early Oligocene up to biozone NP23 determined from the presence of Sphenolithus predistentus and S. distentus (27.14–30.0 Ma). Radiochronological data from the lower volcanic intercalations have revealed an age of ~36 Ma (Maravelis et al., 2016).

- Several hundred meters upward in the sequence there is a change to thick sandstones-conglomerates of variable thickness, depending on the position of the area within the lobes of submarine fans. An average thickness of the conglomerates at the central part of Eastern Limnos is 150–200 m. Its age has been determined as Late Oligocene (27.14–26.81 Ma, biozone NP24), based on the contemporaneous presence of Sphenolithus ciperoensis and S. distentus.

The stratigraphic sequence continues into the Late Oligocene until the Oligocene/Miocene boundary, with a characteristic N-S section along the western part of Limnos, without important tectonic breaks, from Kaspakas to the northwestern cape of Mourtzouflos at the area of Vigla. The younger ages have been determined at this northwestern part of Limnos with characteristic assemblages of NP25 in between 26.81–24.36 Ma, such as S. ciperoensis and D. bisectus and even up to 23 Ma (biozone NN1) based on the presence of Sphenolithus delphix.

Impressive volcanic dikes and lava flows become frequent towards the upper horizons. However, the most extensive volcanic extrusions occur at the central-southern part of Limnos and they are dated as Early Miocene (18–22 Ma; Pe-Piper and Piper, 2002). Thick pyroclastic deposits cover unconformably the previous sedimentary sequence in central Limnos, producing characteristic morphological cliffs due to their erosional style.

The overall stratigraphic sequence of Limnos together with its equivalent sequence of Thrace shows a molassic type deep marine environment within a back-arc basin (Papanikolaou, 1993, 2013) as this is shown: 1) by the unconformable deposition of the Paleogene clastic sediments on a varietated Alpine basement, belonging either to the Circum Rhodope belt along its northern margin, deformed during the Late Jurassic with deposition of unconformable neritic limestones in Early Cretaceous (Aliki Limestones, west of Alexandroupolis), or to the Eastern Greece unit of the Internal Hellenides along the southern margin, deformed in Early Eocene, 2) by the co-existence of the volcanic arc within this North Aegean - Thrace Basin. In fact, flysch type deposits during this period of Late Eocene - Oligocene occur at the fore-arc basins of the External Hellenides fold and thrust belt (e.g. Tripolis, Ionian etc.).

Correlations with the Thrace Basin

The above stratigraphic sequence of Limnos can be correlated with the stratigraphy of the similar sequences around Alexandroupolis in the Western Thrace basin (Papanikolaou and Triantaphyllou, 2010). The Limnos sequence can be correlated with the upper Group of the Pylaea formation, whereas the Lower group of the Kirki formation is not cropping out on Limnos, but it could occur deeper. The characteristic formation of the Upper Eocene Avantas neritic limestones, separating the two clastic sequences in Alexandroupolis can be correlated with the olistolite horizon of Southeast Limnos, where the same neritic limestones occur as blocks, slided within a deep basin. Generally, the sedimentary facies of the Limnos clastic sequence corresponds to a much deeper setting than that of the Alexandroupolis area.

Volcanism is also present in Alexandroupolis in the Upper Eocene-Oligocene Kirki sequence (related also to the metalliferous deposits of Kirki) but also in the higher horizons of the Oligocene Pylaea sequence with volcanic extrusions also in the Early Miocene.

The Lower Miocene volcanic breccia of Limnos, unconformably overlying the Limnos clastic sequence, can be correlated to the Aghios Efstratios pyroclastic sequence as well as to the pyroclastic sequences of Northern Lesbos Island.

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