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NUMERICAL MODELLING OF A SINGLE INTRA-OCEANIC SUBDUCTION FOR THE ORIGIN OF THE BALKAN OPHIOLITES

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INTRODUCTION

The question of the closure of the last Mesozoic oceanic domain in the Balkans has long been a topic of research and debate [1]. The Vardar zone, that sweeps through the central axis of the Balkan Peninsula, traces the position of the final closure of the Vardar branch of Tethys ocean. This zone, comprised of two ophiolite belts (Eastern and Western Vardar) as well as the suture zone, has long been studied and subdivided in various ways [1,2]. Even though many questions surrounding the geodynamics of the Vardar Tethys have been answered (e.g. the number of oceanic domains in the Jurassic and the obduction time of Eastern and Western Vardar ophiolites), there is still controversy about the exact time of the final closure of the last Tethyian ocean. While many authors argue that the ocean existed throughout the Cretaceous [3,4], others question the presumed 'subduction' character of the related Upper Cretaceous magmatism [5-7]. On the other hand, there is a question of how two structurally and compisitionally distinct ophiolite belts can be emplaced via the consumption of a single ocean. This phenomenon is sometimes explained by the operation of two separate subduction systems [8], or by a single intra-oceanic subduction [9]. In this contribution, we report on our recent findings [10], based on the application of numerical geodynamic modelling. Numerical modelling has undergone rapid advances in the last two decades, resulting in both fundamental research and application to various geological terrains [11,12]. Below we describe the model setup and the results of the numerical simulation of the intra-oceanic subduction of Vardar Tethys and emplacement of Vardar ophiolites.

MODEL SETUP

We have used numerical modelling based on conservative finite differences with marker-in-cell method [13]. The equations (Continuity, Stokes and Temperature equations) are discretized on a staggered grid and material properties are defined on mobile material markers. Advection is solved by utilizing fourth order Runge-Kuta schemes. Model domain is defined on the grid that encompasses 4000x1400km area. All boundary conditions for velocity are free-slip. Free surface is simulated via 20km of „sticky air". Basic erosion and sedimentation calculation is implemented on this surface. Temperature is constant at the top and bottom boundaries, while vertical boundaries are insulating. Temperature increases adiabatically (0.45K/km) within the mantle. Rheology of the rocks is visco-plastic. Hydration and partial melting are accounted for. Plate convergence is achieved via internal velocity boundary condition within the continental plates.

RESULTS AND DISCUSSION

Initial configuration of the constructed 2D model represents Vardar Tethys at the start of intra-oceanic subduction, situated between two continental lithospheres, namely Europe and Adria. The subduction is initiated along the mid-oceanic ridge (rheologically weakened) by imposing the overal plate convergence of 4cm/y (Fig. 1). The subduction develops for approximatelly 12Myrs when the steepening of the subduction angle is accompannied with slab rollback and extension in the back-arc. The back-arc basin develops and a short-lived East Vardar marginal ocean spreads along the European margin. On the oposite side, portions of the oceanic lithosphere are obducted onto Adria (Western Vardar). Continued convergence results in the complete consumption of the oceanic lithosphere within 25Myrs (Upper Jurassic). The modelling indicates that a single intra-oceanic subduction is sufficient to produce bakc-arc extension and the emplacement of two distinct ophiolite belts. This is in line with the idea of Uppermost

Jurassic/Lowermost Cretaceous closure of Vardar branch of Tethys.

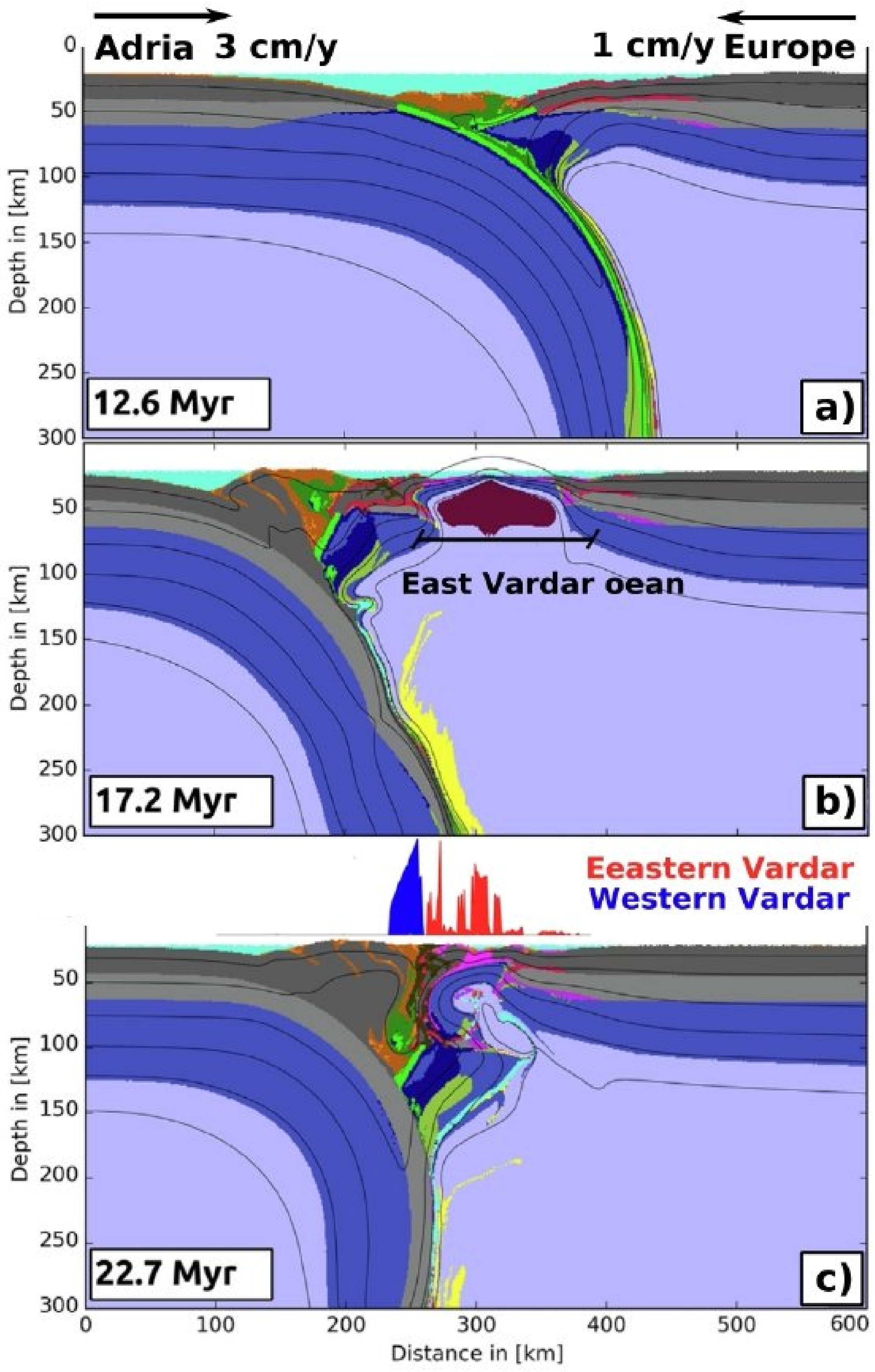

Figure 1. Time evolution of the subduction of Vardar Tethys with different ophiolites indicated. Modified from [10].

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